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HANDBOOK OF ANATOMY FOR STUDENTS OF MASSAGE

MARGARET E. BJÖRKEGREN

SECOND EDITION

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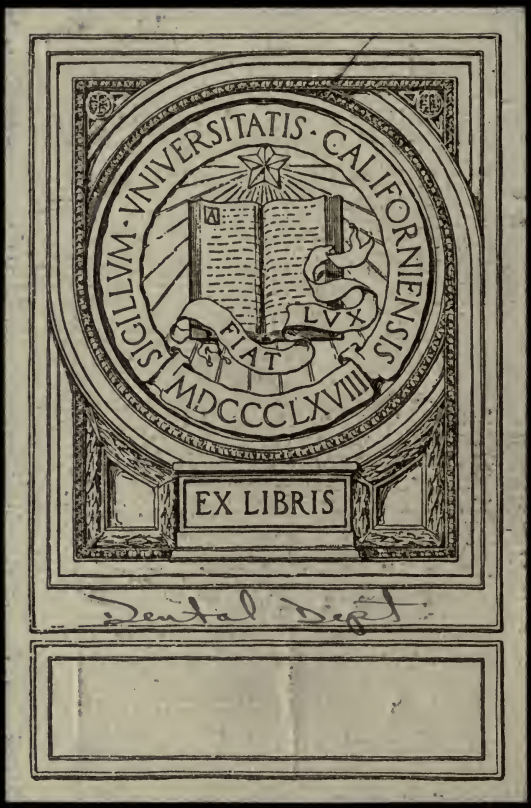
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HANDBOOK OF ANATOMY FOR STUDENTS OF MASSAGE

HANDBOOK OF ANATOMY FOR STUDENTS OF MASSAGE

BY

MARGARET E. BJÖRKEGREN

TEACHERS' CERTIFICATE, INCORPORATED SOCIETY TRAINED MASSEUSES
INTER. (M.B.) LOND.

SECOND EDITION

WITH 73 ILLUSTRATIONS

TAKEN FROM "A MANUAL OF ANATOMY," BY A. M. BUCHANAN, M.A., M.D., PROFESSOR OF ANATOMY, ANDERSON'S COLLEGE, GLASGOW

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PREFACE TO THE SECOND EDITION

In preparing the Second Edition I have made numerous alterations and small additions which I trust will improve the usefulness of the book, the principal alteration being the considerable enlargement of the chapter on Surface Markings, which I recognized was not adequate to the standard required by the examinations of the Incorporated Society of Trained Masseuses.

MARGARET E. BJÖRKEGREN.

London,
May, 1917.

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PREFACE TO THE FIRST EDITION

This book has been compiled with the object of meeting a want, to which my attention was repeatedly called by my students when preparing them for the examinations of the Incorporated Society of Trained Masseuses. No book dealing with Anatomy, especially arranged for students of massage, has yet been written, and I have endeavoured to make good this deficiency to the best of my ability. It is hoped that this small volume will be found to embody all the ground covered by the syllabus of this Society for its examinations in Massage and Swedish Remedial Exercises.

Professor A. M. Buchanan of Glasgow has been good enough to allow me to select what illustrations I have thought necessary from his "Manual of Anatomy." I take this opportunity of tendering him my sincere thanks for his courtesy. Through his kindness I am thus able to offer my readers a far better and more freely illustrated book than would have been possible if special figures had had to be made. In a few of the illustrations some parts are shown which are not referred to in the text. As the pointers to them appeared in the original figures, it was considered advisable to retain them, since their removal might have caused damage.

Within the scope of a small work it is obviously impossible to include more details and explanations than are absolutely necessary; but it will, I hope, be found sufficiently full and accurate to render it a useful textbook for those attending classes and lectures on Massage, and afterwards to be of assistance to them in their practice.

MARGARET E. BJÖRKEGREN.

London,
September, 1914.

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SECTION I

INTRODUCTION

Anatomy means really the study of the body, its different parts and their functions, comprising histology, physiology, and many other sciences; but the generally accepted definition is, that the science of anatomy is the study of the body as far as it can be done by dissection and the naked eye. It is necessary, therefore, to have certain well-defined terms for the purposes of description; it is always assumed that the body is in the erect position with the arms by the sides, the palms turned forwards and the thumbs outward.

Sections are generally taken through the three following planes:

1. Transverse, or horizontal plane.
2. Sagittal—a vertical plane in the antero-posterior direction.
3. Frontal—a vertical plane at right angles to the sagittal.

The Mesial Plane is the sagittal one that divides the body in two halves, and is represented in front by the anterior median line, and behind by the posterior median line: the two halves are supposed to be symmetrical; but like all things of Nature's manufacture, are not rigidly so. Certain unpaired organs, that are not in the middle line, also render the two halves asymmetrical.

The terms *internal* and *external* are used to express positions nearer to, or farther from, the middle line respectively; the terms *dorsal* and *ventral* are positions nearer the back or front of the body respectively; *posterior* and *anterior* are synonymous with dorsal and ventral; *superior* and *inferior* indicate nearer the head or the feet respectively. In the case of the limbs, the

terms *proximal* and *distal* are used to indicate positions near to or distant from the trunk.

The body consists of a bony framework, the component parts of which are jointed together, the joints being the fulcrums of the levers formed by the muscles. As well as the skeletal and muscular systems, the circulatory, respiratory, digestive, and nervous systems also have to be studied.

The Skeletal System.—The bones are classed as long, short, flat, or irregular, according to their shape. They are all laid down in cartilage in the embryo, and become ossified at different stages. Various centres of ossification are laid down in different parts of the bone, so that each part can continue growing until the adult size is reached, by which time the different centres of ossification have coalesced and the bone is completely ossified. A sesamoid bone is one that is developed in a tendon passing over a joint where there is a great deal of friction.

Joints are formed by the ends of two bones in apposition to one another. Fibrous bands, called "ligaments," hold them together, and these generally join one another so as to form a complete capsule round the joint. The opposed ends of the bones are covered with cartilage of a particularly tough kind to prevent wear by friction. In some cases where the joint has constant work—*e.g.*, the knee-joint—an extra piece of cartilage in the form of a disc is found between the bones. The whole structure is lined by synovial membrane—a thin membrane which secretes a fluid for the purpose of lubrication.

The skeleton consists of a vertebral column which supports the trunk, and on the top of which is the head, on the freely movable cervical vertebræ; the lower end of the vertebral column is firmly welded together to support the weight of the body. The upper half of the body—the thorax—is protected by a bony framework formed by the ribs, which are elastic and freely movable, to give free play to the lungs. The lower half of the trunk, the abdomen, has only partial bony protection and a strong muscular wall composed of three layers of muscles with the fibres arranged in different directions, so that they can exert strong contractile force.

The limbs are similiar in structure as to the number and

arrangement of their bones and joints; but in every particular it will be noticed that the upper limb is constructed with a view to wide scope of movement and lightness, whereas the construction of the lower limb tends to stability and weight. They are each attached by a ball-and-socket joint to a bony girdle. But compare the shoulder girdle with the pelvic: the socket in the one case is shallow and much smaller than the ball; in the other the ball is received into a deep socket that covers it up to the neck. The shoulder-girdle is connected anteriorly to the trunk by a loose gliding joint, and posteriorly slung by muscles. The pelvic girdle is firmly welded together in front, and behind is almost immovably joined to the lower vertebræ, whose joints are completely ossified. The reason for this is easily seen when the functions of the upper and lower limbs are compared.

The Muscular System.—The flesh of the body consists of a number of muscles which are attached at each end to bones. They are capable of contraction, the attachment from which they pull being termed the "origin," and the one *on* which they pull, the "insertion." A muscle or its tendon passes over one or more joints, and its principal action is on the joint nearest the insertion.

The Circulatory System.—The tissues are nourished by the blood, which is carried to all parts by the arteries and returned by the veins. The heart is the starting-point of the system, and by its action the blood is sent on its way at a certain pressure.

The Respiratory System consists of an air passage from the mouth and nose to the lungs, the latter situated in the thorax, where the blood is reoxygenated.

The Digestive System consists of the alimentary canal, by which food is taken in at the mouth, passed down to the stomach and duodenum to be digested, into the small intestine to be absorbed, and the residue into the large intestine to be excreted. Accessories to the digestive system are the organs which secrete digestive juices and pour them into the alimentary canal.

The Nervous System is in two parts—the cerebro-spinal

and sympathetic. The cerebro-spinal, consisting of the brain and spinal cord, is formed largely of grey matter, which consists of the actual nerve cells, and sends distributing fibres in every direction, so that each muscle receives both an efferent and afferent branch. The sympathetic is an accessory system.

The whole body is covered by a thin tough membrane called the "deep fascia," which closely invests the muscles, and sends down processes, or dividing septa, between them. From the deep fascia and the intermuscular septa many of the muscles get additional origins, and in some cases muscles are inserted into adjacent fascia as well as bones. Outside this is the superficial fascia, a thin friable membrane enclosing fat in its meshes. This fascia is also found in spaces between muscles, bones, and organs to prevent jarring and give elasticity. Over all is the skin, from which the hair and nails are developed.

SECTION II

THE SHOULDER GIRDLE AND UPPER LIMB

The upper limb is articulated to the trunk by means of a ball-and-socket joint between the humerus and scapula. The limb is slung to insure as much mobility as possible, the joint being a very loose one, and the scapula is attached to the trunk by muscles between it and the vertebræ at the back, and to the clavicle in front. The scapulæ and clavicles form what is known as the **Shoulder Girdle.**

The bones to be described in the shoulder girdle and upper limb are the following:

Clavicle, articulated internally to the sternum; externally, to the acromion process of scapula.

Scapula, articulated externally to acromial end of clavicle and to head of humerus.

Humerus, articulated above to glenoid cavity of scapula; below, to heads of ulna and radius.

Ulna, articulated above to internal condyle of humerus and to head of radius; below, to triangular fibro-cartilage of wrist-joint.

Radius, articulated above to external condyle of humerus and to head of ulna; below, to the scaphoid and semilunar bones of the carpus.

Carpus, articulated above to radius; below, to five metatarsals.

Metatarsals, articulated above to bones of carpus; below, to phalanges.

Phalanges: First row—articulated above to metatarsals; below, to second row of phalanges.

Second row—above, to first row of phalanges; below, to third row of phalanges.

Third row—above, to second row of phalanges.

The **Clavicle** is a long bone having a prismatic shaft, and at its inner (sternal) end a rounded head; while its outer (acromial) end is flattened into a more or less square shape. The shaft forms a double curve, being convex forwards internally and convex backwards externally; the upper surface, subcutaneous throughout, is rounded and smooth; the anterior border is rough, internally for the attachment of the pectoralis major, and externally for that of the deltoid; the posterior border is roughened internally for the attachment of the sterno-mastoid, and externally, where the acromion process begins, there is a tubercle, called the conoid tubercle, for the attachment of the conoid ligament. The inferior surface is also rough; at its

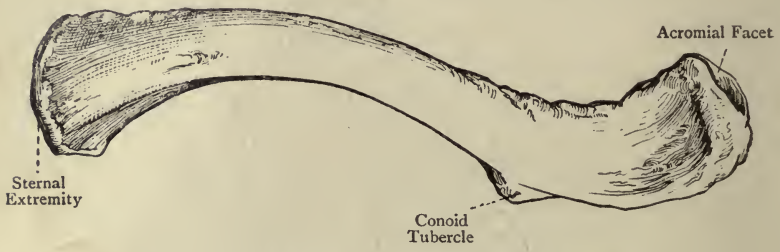


Fig. 1.—The Right Clavicle (Superior View).

sternal end there is a deep pit for the attachment of the rhomboid ligament, and in its middle third a groove for the subclavian muscle; from the conoid tubercle, outwards and forwards, proceeds an oblique ridge for the attachment of the trapezoid ligament.

The clavicle articulates internally with the upper end of the sternum, and externally with the acromion process of the scapula.

Ossification.—The clavicle is the first bone of the body to ossify, the process commencing in the shaft very early in fœtal life. The secondary centre, or epiphysis, appears at the sternal end in adult life, and ossification is complete about the twenty-fifth year.

The **Scapula** is a flat, triangular bone having two surfaces, anterior and posterior, and three margins, vertebral, axillary, and

superior. Between the upper and second fourth of the vertebral border on the posterior surface there starts a process, which passes right across the dorsum of the bone, and ends in the acromion process. From the external end of the superior border projects a beak-like process called the coracoid. Immediately to the inner side of the root of the coracoid process is the suprascapular notch.

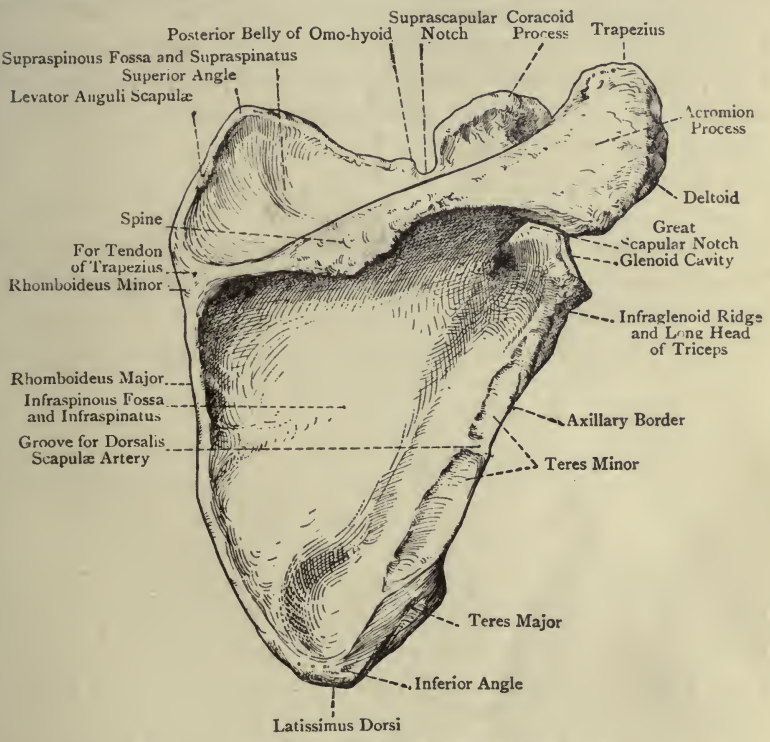


FIG. 2.—THE RIGHT SCAPULA (POSTERIOR VIEW).

The superior angle (vertebral end of superior border) is more or less rectangular, and the inferior angle very acute. At the junction of the outer end of the superior border and the upper end of the axillary border is the glenoid cavity, a pyriform, slightly concave area, which receives the head of the humerus, thus forming the shoulder-joint. The coracoid process arises just internal to the glenoid cavity, and, bending on itself forwards

and outwards, overhangs the glenoid surface; it is very much roughened for the attachment of muscles and ligaments.

The anterior, or ventral, surface of the bone is concave, and has several rough lines on it, caused by the attachment of the subscapular muscle. The axillary border on this surface is full and rounded, the vertebral border being roughened. Both borders give attachment to muscles.

The posterior dorsal surface is divided into an upper smaller fossa and a lower larger fossa by the spine, which runs from the vertebral border outwards and upwards to the glenoid cavity. Both fossæ give attachment to muscles. The spine is separated from the edge of the glenoid cavity by the great scapular notch; the posterior border is subcutaneous, and is lipped for the attachment of muscles; at the great scapular notch it is flattened to form the acromion process, which passes forwards and outwards to overhang the joint, and gives attachment to muscles and ligaments.

The scapula articulates by means of the glenoid cavity with the head of the humerus, and by the acromion process with the acromial end of the clavicle.

Ossification.—At birth the coracoid and acromion processes, the glenoid cavity, and vertebral border are still cartilaginous. Secondary centres appear in these from birth up to puberty, and the bone is complete about the twentieth year.

The **Humerus** is a long bone with a shaft and two extremities; it is the bone of the upper arm. It has a rounded head forming about one-third of a sphere, which is bounded by the anatomical neck, a shallow depression all round the head, much less marked inferiorly. On the outer side of the head is the great tuberosity, which becomes continuous with the shaft, and has facets for the attachment of muscles. On the anterior surface of the upper end is the lesser tuberosity, which also becomes continuous with the shaft. Between the two tuberosities lies the bicipital groove, which gives attachment to the adductor muscles. Below the head and tuberosities the bone decreases in size, and this is called the "surgical neck," as it is the part most easily fractured.

The shaft is cylindrical above, but gets flatter lower down.

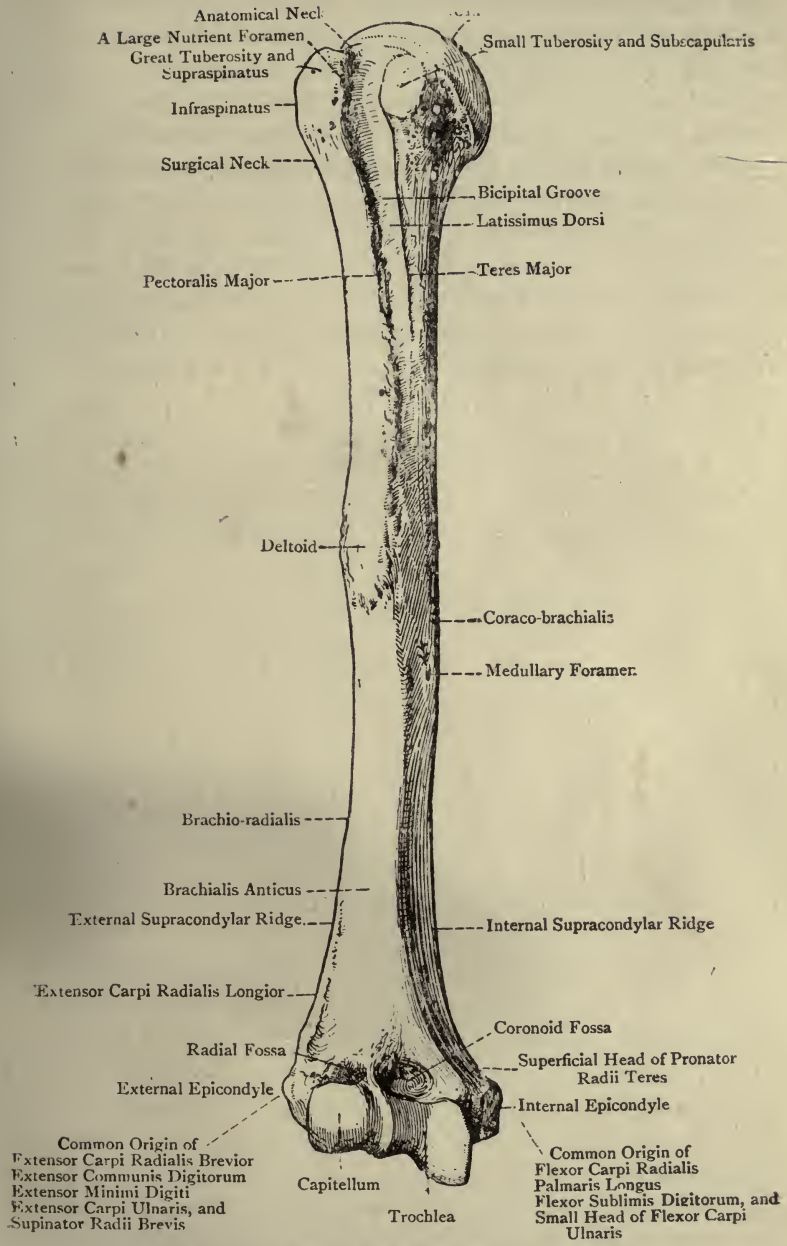


FIG. 3.—THE RIGHT HUMERUS (ANTERIOR VIEW).

The bicipital groove passes down its anterior surface, directed slightly to the inner side, and gradually fades away. About the middle of the inner and outer surfaces are rough surfaces for the insertions of the coraco-brachialis and deltoid respectively. On the posterior surface a shallow groove—the musculo-spiral groove—winds from within outwards, separating the origins of two heads of the triceps. The lower end of the shaft is flattened and expanded into two condyles, of which the inner is larger than the outer. From each of these condyles a ridge runs up for about one-third of the shaft. Between the two condyles are the trochlear and capitellar surfaces for the articulation of the ulna and radius respectively. The trochlea is a grooved surface, which winds spirally round the inferior end of the bone and shows on the posterior surface. The capitellum is on the outer side of the trochlea, a small, rounded surface which shows only on the anterior surface. Above the trochlea, both anteriorly and posteriorly, are small, round fossæ, the coronoid and olecranon respectively, for articulation with the processes of the ulna in extreme flexion and extension.

The humerus articulates, by means of its rounded head, with the glenoid cavity of the scapula, and at its inferior end with the ulna and radius.

Ossification.—The primary centre for the shaft appears before birth. Secondary centres for the two tuberosities and the head appear during the first few years of life, and these three first unite, forming an epiphysis, which unites with the shaft as a whole in adult life. A similar arrangement is observed with the condyles and articular surfaces of the lower end, which also form a separate epiphysis.

The **Ulna,** the inner bone of the forearm, is a long bone with a shaft and two extremities. The head is formed of two processes, the olecranon posteriorly and the coronoid anteriorly. The olecranon process forms a continuation of the shaft, and is hollowed out anteriorly for articulation with the trochlear surface of the humerus. The coronoid process juts out from the anterior surface of the shaft, and its upper surface is in continuation with the anterior surface of the olecranon process, the two between them forming the semilunar notch or sigmoid fossa.

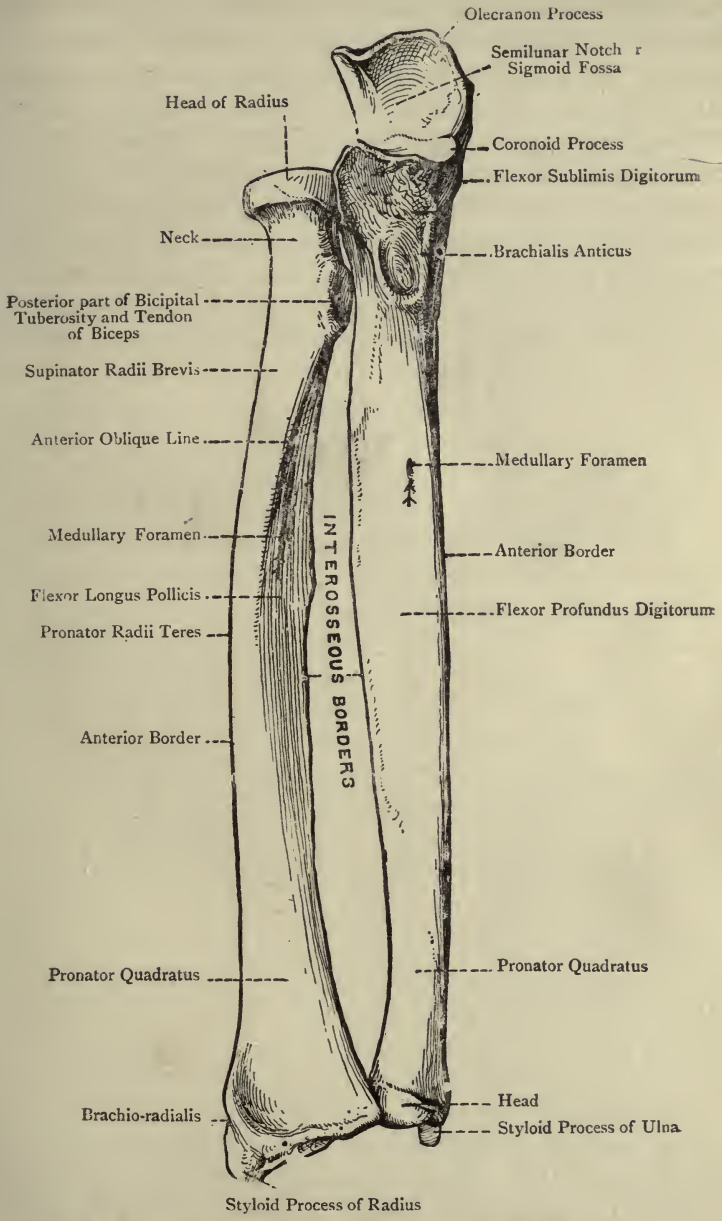


FIG. 4.—THE RIGHT RADIUS AND ULNA (ANTERIOR VIEW).

On the outer side of the upper end of the shaft is another articular surface, the radial notch, for articulation with the head of the radius. The posterior surface of the olecranon is smooth and subcutaneous. Just below the coronoid process is a rough tuberosity for the insertion of brachialis anticus. The shaft is triangular for about two-thirds of its length, then tapers gradually, and becomes smooth and rounded. It has three surfaces—anterior, inner, and outer—and three borders—posterior, inner, and interosseous. The posterior border is subcutaneous throughout its length. The lower end of the bone is much smaller than the upper, and nearly circular. On its inner surface it has a projection, the styloid process, pointing downwards, and on its outer surface an articular facet for the lower end of the radius. The inferior surface is smooth for articulation with the triangular fibro-cartilage of the wrist-joint.

The ulna articulates above with the trochlear surface of the humerus by means of the semilunar notch, and below with the articular disc of the wrist-joint; on its outer surface it articulates with the radius at either extremity.

Ossification.—The centre for the shaft appears before birth, and secondary centres for the olecranon process and the lower end of the shaft appear later to form epiphyses which unite with the shaft in adult life.

The **Radius,** the bone on the outer side of the forearm, is a long bone with a shaft and two extremities; it differs from the ulna in having a small rounded head and a shaft which gradually widens out so that the lower extremity is much larger and triangular in shape. The head is circular, with a cup-shaped depression on its superior surface; it has a narrow articular surface all round for articulation with the radial notch of the ulna. Immediately below the head it is somewhat constricted to form a neck, and then widens out again into the shaft. The shaft is triangular in section, having three surfaces—anterior, outer, and posterior—and three borders, the interosseous one being the only well-defined one, as the surface is rounded and confluent with the other two. At the upper and inner side of the anterior surface is the bicipital tuberosity for the insertion of the biceps, and from the lower edge of that the oblique line

passes across the anterior surface of the bone to the middle of the outer border. The lower end of the shaft is distinctly triangular; the edge of the narrow interosseous surface articulates with the lower end of the ulna; the anterior surface is smooth and concave, the posterior having a series of grooves for the extensor tendons to work in. On the radial border is a styloid process similar to that of the ulna.

The radius articulates above by means of the upper surface of its head with the capitellum of the humerus, and the lower end articulates with the scaphoid and semilunar bones of the carpus; on its interosseous surface it articulates at both ends with the ulna.

Ossification.—Similar to that of the ulna.

The **Carpus** consists of eight bones arranged in two rows of four. The proximal row beginning from the radial side are scaphoid, semilunar, cuneiform, and pisiform; the distal row, beginning from the radial side, are trapezium, trapezoid, os magnum and unciform. They are all small irregular-shaped bones articulating with one another. The bones are articulated so that their united surface is convex backwards.

The pisiform is the smallest of the bones and is a little round bone resting entirely on the palmar surface of the cuneiform; it, with the hook of the unciform, forms the projection on the ulnar side of the wrist; the tubercle of the scaphoid and ridge of the trapezium form the projection on the radial side of the wrist.

The unciform is distinguished by having a hook-like process on its palmar surface.

The proximal row of bones articulates above with the radius and triangular fibro-cartilage, and below with the distal row of bones. The distal row of bones articulates below with the five metatarsal bones; the first metatarsal with the trapezium; the other four fitted into the trapezoid, os magnum, and unciform.

Ossification.—One centre for each bone appears after birth, and the carpus is usually completely ossified at puberty.

The **Metacarpus** consists of five bones; they are all long bones, with a shaft and two extremities. The shafts are constricted in the middle and curved so that they are slightly

convex backwards; the carpal ends or bases of all, except the first, are more or less wedge-shaped, and the heads of all are rounded.

The first metacarpal is the shortest and stoutest of the five

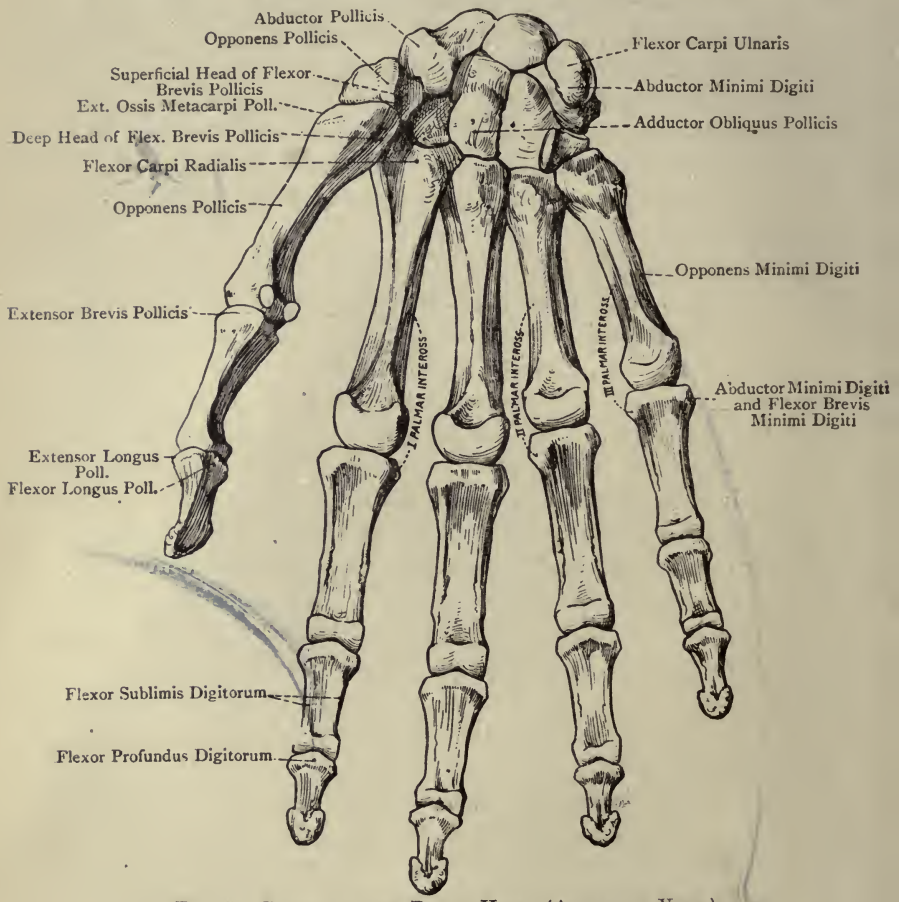


FIG. 5.—BONES OF THE RIGHT HAND (ANTERIOR VIEW).

and has a saddle-shaped base for articulation with the trapezium. It supports only two phalanges.

The second metacarpal is the longest, and the other three gradually decrease in length. They articulate with one another at their carpal ends, and with the trapezoid, os magnum, and

unciform in order. Each of the four inner metacarpals supports three phalanges.

The third metacarpal has a styloid process from its base on the radial side.

Ossification.—The four inner metacarpals have a primary centre for the shafts and bases developed before birth, and the heads form a secondary epiphysis. The first metacarpal has the head and shaft formed from the primary centre and the base from the secondary centre.

The **Phalanges** are fourteen in number, two on the first metacarpal and three each on the other four. The first phalanx is the largest of the three, the terminal ones being much smaller. They are short stout bones articulating with the metacarpals and one another.

The terminal phalanges have flattened distal extremities to support the nails.

Ossification.—Similar to that of the first metacarpal bone.

Sterno-Clavicular Joint, between the sternal end of the clavicle and the outer part of the upper edge of the sternum. A gliding joint, so only gliding movements possible. There are no movements round a distinct axis, but movements which depress or raise the scapula will cause the clavicle to move also, in both its joints.

Ligaments.—The joint is surrounded by a capsule attached to the edges of the articular surfaces of the bones, which is strengthened to form anterior and posterior ligaments. In addition there is a meniscus, or disc of fibro-cartilage, between the two articular surfaces.

Accessory Ligaments: Interclavicular, attached to the sternal end of the clavicle and the suprasternal notch. It is continuous with the one of the other side. This ligament prevents the end of the clavicle being raised up too much when the acromial end is depressed as in carrying heavy weights.

Rhomboid, attached to the under surface of the sternal end of the clavicle and the upper surface of the first costal cartilage; it limits the movements of the clavicle when the arms are raised over the head.

The *synovial membrane* lines the two joint cavities which are separated by the meniscus.

Acromio-Clavicular Joint, between the acromial end of the clavicle and the acromion process of the scapula.

A gliding joint similar in movement and function to the sterno-clavicular joint. The two joints give elasticity and increased movement to the shoulder girdle.

Ligaments.—A capsule surrounds the joint, which is strengthened to form superior and inferior ligaments. There is often a meniscus of fibro-cartilage to be found in this joint too, but not invariably.

Accessory Ligaments: Coraco-clavicular between the acromial end of the clavicle and the coracoid process of the scapula. It is in two parts, viz.—

Conoid—a triangular ligament attached by its apex to the upper surface of the coracoid process and by its base to the conoid tubercle of the clavicle.

Trapezoid—a ligament on the outer side of the conoid and attached to the upper surface of the coracoid process and to the oblique line from the conoid tubercle.

MOVEMENTS OF SHOULDER GIRDLE TAKING PLACE AT STERNO- AND ACROMIO-CLAVICULAR JOINTS.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Elevation	Trapezius (upper fibres)	Inner third superior curved line of occipital bone and external occipital protuberance from the ligamentum nuchæ, the spine and supraspinous ligaments of the seventh cervical, and all the thoracic vertebræ	Outer third of the posterior surface of the clavicle; inner border of the acromion process, and the upper border of the spine of the scapula, and the rough triangular surface at the base of the spine	Spinal accessory and nerves from the cervical plexus
	Levator anguli scapulæ	Posterior tubercles of the transverse processes of the upper cervical vertebræ between scalenus medius and splenius colli	The upper fourth of the vertebral border of the scapula from the spine to the angle	Cervical plexus; posterior scapular
	Rhomboideus major	Spines of the thoracic vertebræ, second to fifth inclusive	The vertebral border of the scapula from the spine to the lower angle to a membranous band attached by the extremities	Posterior scapular

MOVEMENTS OF SHOULDER GIRDLE TAKING PLACE AT STERNO- AND ACROMIO-CLAVICULAR JOINTS—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Elevation	Rhomboideus minor	Spines of seventh cervical and first thoracic vertebræ	The vertebral border of the scapula opposite the base of the spine	Posterior scapular
	Sterno-mastoid	A narrow head from the anterior surface of sternum, and also from inner third of upper surface of clavicle	Outer surface of mastoid process, and the outer half of the superior curved line of the occipital bone	Spinal accessory and cervical plexus
Depression	Trapezius (lower fibres)	See Elevation		
	Subclavius	Upper surface of first costal cartilage	Middle third of under surface of clavicle	Brachial plexus
	Pectoralis minor	From the anterior part of upper border of third, fourth, and fifth ribs and fascia covering them	Outer half of upper surface of coracoid process	External and internal anterior thoracic
	Latissimus dorsi	From the spines of the lower six thoracic, and of all the lumbar vertebræ; the posterior part of the iliac crest; slips from the lower four ribs and the inferior angle of the scapula; and deep fascia covering back	The floor of the bicipital groove on the humerus	Third subscapular
	Pectoralis major (lower fibres)	From the inner half of the anterior surface of the clavicle; from half the anterior surface of the sternum in its whole length; and from the cartilages of the upper six ribs	The outer lip of the bicipital groove on the humerus	External and internal anterior thoracic
Forwards	Serratus magnus	From outer aspect of upper eight or nine ribs	The ventral surface of the vertebral border of the scapula in its whole length	Posterior thoracic
	Pectoralis major	See Depression		
	Pectoralis minor	See Depression		
Backwards	Trapezius	See Depression		
	Rhomboids	See Elevation		
	Latissimus dorsi	See Depression		

Shoulder-Joint, between the head of the humerus and the glenoid cavity of the scapula.

A ball-and-socket joint, permitting of particularly free movement as the socket is very shallow and much smaller than the ball. Movement can take place round three axes, viz.—

Transverse—flexion and extension.
Antero-posterior—abduction and adduction.
Vertical—rotation in and out.

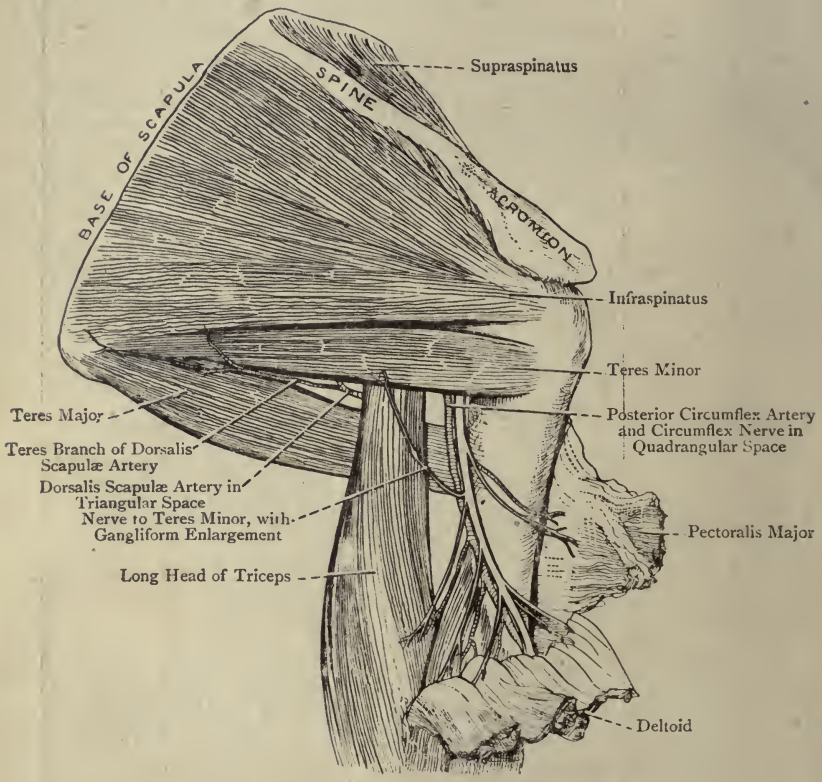


FIG. 6.—MUSCLES OF THE SHOULDER-JOINT.

Ligaments.—A capsule surrounds the joint attached to the anatomical neck of the humerus and the edge of the glenoid fossa outside the ligament. Inferiorly the attachment of the capsule runs down a little way on the shaft of the humerus.

The capsule is very loose, so that were it not for atmospheric pressure the humerus could be pulled at least an inch away from the scapula; this adds to the mobility of the joint.

Glenoid ligament, a band of circular fibres round the edge of the glenoid fossa to deepen the socket.

Transverse humeral ligament bridges over the bicipital groove and allows the tendon of the biceps to pass under it.

Coraco-humeral ligament between the root of the coracoid process and the upper surface of the head of the humerus.

Gleno-humeral ligaments, three in number, from the anterior edge of the glenoid fossa to the anterior surface of the head of the humerus.

All these ligaments are in reality part of the capsule.

Accessory Ligaments: Coraco-acromial ligament, a strong band of fibres passing between the coracoid and acromion processes. This arches over the top of the joint and prevents dislocation upwards.

The tendons of subscapularis, supra- and infra-spinatus are closely applied to the capsule of the joint as they near their insertions, so strengthening it; but it will be noticed that the joint is weak inferiorly, having no strengthening ligaments in that aspect.

The tendon of the biceps from the edge of the glenoid fossa passes through the joint over the head of the humerus, emerging from under the transverse ligament.

The *synovial membrane* is very extensive, lining all the joint, and is prolonged down on the tendon of the biceps.

MUSCLES ACTING ON THE JOINT.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Deltoid (anterior fibres)	Outer third of anterior surface of clavicle; outer border of acromion process; lower edge spine of scapula; and deep fascia	In a V-shaped impression half-way down the outer surface of the humerus	Circumflex
	Pectoralis major	See Sterno-Clavicular Joint		

MUSCLES ACTING ON THE JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion (*continued*)	Coraco-brachialis	With short head of biceps from tip of coracoid process	Into a rough linear impression half-way down the inner surface of the humerus	Musculo-cutaneous
	Subscapularis	From the whole of the subscapular fossa and the groove along the axillary border, excepting at the angles of the bone	Lesser tuberosity of humerus and capsule of shoulder-joint	First and third subscapular
	Biceps	1. Short head from the tip of the coracoid process with coraco-brachialis. 2. Long head from the edge of the glenoid fossa at the root of the coracoid process	Rough posterior portion of bicipital tubercle of radius, and by a prolongation of the fascia of the deep fascia of the forearm (see Bicipital Fascia, p. 37)	Musculo-cutaneous
Extension	Deltoid (post-fibres)	See Flexion		
	Teres major	From the lower third of the axillary border of the dorsum of the scapula, and from deep fascia	Inner lip of bicipital groove	Second subscapular nerve
	Infraspinatus	From the infraspinous fossa and deep fascia	The middle facet on the great tuberosity of the humerus	Suprascapular
	Latissimus dorsi	See Sterno-Clavicular Joint		
	Triceps	1. Long head from a rough surface on the axillary border of the scapula just below the glenoid fossa. 2. Outer head from posterior surface of humerus between the musculo-spiral groove and the insertion of teres minor, a linear impression 3. Inner head from the posterior surface of the humerus, from the musculo-spiral groove almost to the condyles and deep fascia	By one tendon inserted on the posterior part of the upper end of the olecranon process of the ulna	Musculo-spiral

MUSCLES ACTING ON THE JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Abduction	Deltoid	See Flexion		
	Supra-spinatus	From the supraspinous fossa and deep fascia	To the uppermost facet on the great tuberosity of the humerus	Supra-scapular
Adduction	Pectoralis major	See Sterno-Clavicular	Joint	
	Latissimus dorsi	See Sterno-Clavicular	Joint	
	Teres major	See Extension		
	Coraco-brachialis	See Flexion		
	Biceps (short head)	See Flexion		
	Triceps (long head)	See Extension		
	Teres minor	From the upper two-thirds of the axillary border of the scapula	To the lowest facet on the great tuberosity of the humerus	Circum-flex
	Weight of	limb		
Rotation out	Infra-spinatus	See Extension		
	Teres minor	See Adduction		
Rotation in	Teres major	See Extension		
	Pectoralis major	See Sterno-Clavicular	Joint	
	Latissimus dorsi	See Sterno-Clavicular	Joint	
Circumduction—a		combination of all these	movements	

The **Elbow-Joint,** between the trochlear and capitellar surfaces of the humerus, and the sigmoid fossa of the ulna and depression on the head of the radius.

A hinge-joint permitting of movement round only one axis, viz.—Transverse—flexion and extension.

Ligaments.—The *capsular* ligament is complete and strength-

ened by various bands of fibres. It is attached to the upper borders of the fossæ on the anterior and posterior surfaces of the humerus and the lower aspects of the condyles (not enclosing them in the joint cavity), round the margin of the olecranon process and the inner and anterior margin of the coronoid process, and round the lower edge of the articular surface surrounding the head of the radius—*i.e.*, just above the neck. It will thus be

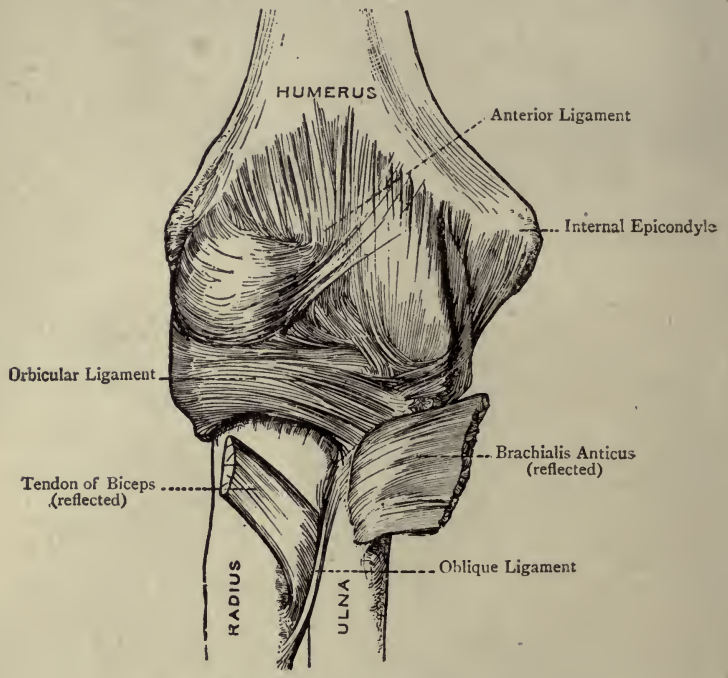


Fig. 7.—The Elbow-Joint.

seen that the elbow-joint encloses within its cavity the superior radio-ulnar joint.

Anterior Ligament, from the upper margins of the coronoid and supracapitellar fossæ on the humerus to the margin of the coronoid process and the orbicular ligament of the radio-ulnar joint. The fibres of this ligament are arranged in several directions to give strength.

Posterior Ligament, from the upper margin of the olecranon

fossa of the humerus to the anterior margin of the upper aspect of the olecranon process of the ulna.

Internal Lateral Ligament is arranged in three parts, forming a triangle: (1) From anterior border of inner condyle to the margin of the coronoid process; (2) from the inferior and posterior border of the condyle to the olecranon process; and (3) from the olecranon process to the coronoid process.

External Lateral Ligament, from the lower border of the outer condyle of the humerus to the orbicular ligament on the radius.

MUSCLES ACTING ON THE ELBOW-JOINT.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Biceps	See Shoulder-Joint		
	Brachialis anticus	From lower two-thirds of anterior surface of shaft of humerus and the intermuscular septa, enclosing above the insertion of the deltoid	The rough tubercle on the anterior surface of the coronoid process of the ulna and the anterior ligament of the elbow-joint	Musculo-cutaneus
	Brachio-radialis	See Radio-Ulnar Joints		
	Pronator radii teres	See Radio-Ulnar Joints		
	Flexors of wrist and fingers	See Wrist and Phalangeal Joints		
	Extensors of wrist (during pronation)	See Wrist and Phalangeal Joints		
Extension	Triceps	See Shoulder-Joint		
	Anconeus	From posterior surface of outer condyle of humerus	The outer surface of olecranon process, back of ulna and deep fascia	Musculo-spiral
	Extensors of	wrist and fingers during	supination	

Cartilage covers the articular surfaces of the joint as usual, but is not prolonged into the fossæ on the humerus, where pads of fat are placed. There is also a narrow gap in the cartilage

covering the surfaces of the olecranon and coronoid processes, thus separating the two.

The *synovial membrane* lines all the joint, including those parts not covered by cartilage, and is continuous with that lining the superior radio-ulnar joint.

The **Radio-Ulnar Joints,** between the extremities of the opposing surfaces of the radius and ulna. These joints are

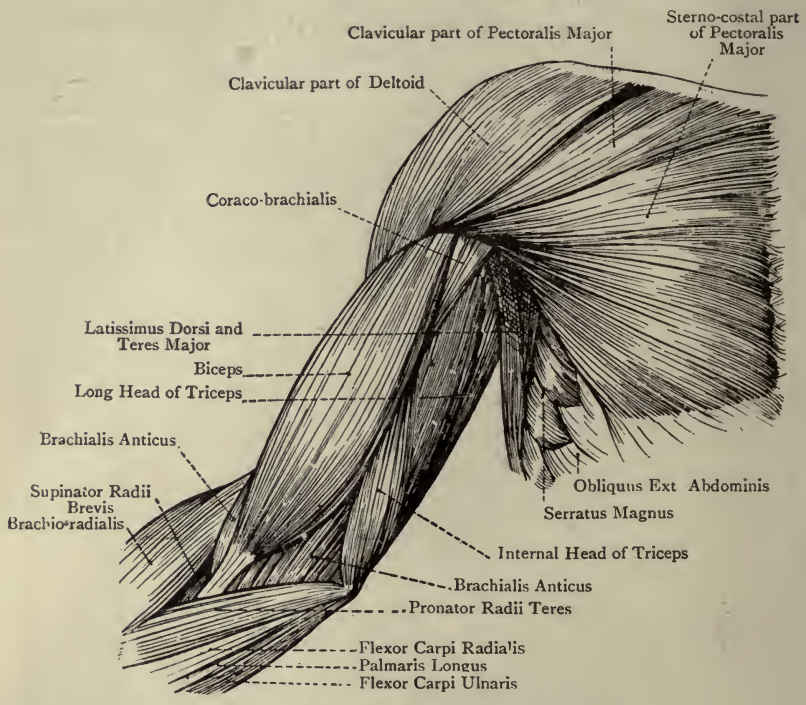


FIG. 8.—MUSCLES OF THE UPPER ARM.

both gliding joints, and by their means the radius is enabled to turn round on the ulna, causing pronation and supination of the hand. (Pronation = palm downwards; supination = palm upwards.)

Superior Radio-Ulnar Joint, between the head of the radius and the radial notch on the outer surface of the ulna.

Ligaments.—Orbicular ligament, a ring of strong tendinous fibres attached to the extremities of the radial notch on the ulna

and encircling the head of the radius; the lower edge of the ring is smaller than the upper, so that the radius is as it were suspended by its head.

Accessory Ligament: *Oblique* ligament, a thin band from the outer surface of the coronoid process of the ulna to the radius, where it is attached just below the bicipital tuberosity.

The *synovial membrane* lines the joint, and is continuous with that of the elbow-joint.

Inferior Radio-Ulnar Joint, between the inner surface of the inferior end of the radius and the outer surface of the inferior end of the ulna; the inferior surface of the lower end of the ulna is also included in the joint by means of the articular disc of cartilage which excludes the ulna from the wrist-joint.

MUSCLES ACTING ON THE RADIO-ULNAR JOINTS.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Supination	Brachio-radialis (supinator longus)	From the upper two-thirds of the external supracondyloid ridge of the humerus	The styloid process of the radius	Musculo-spiral
	Supinator brevis	From the external condyle of the humerus; the external lateral and orbicular ligaments; the triangular surface of the ulna just below the radial notch and the deep fascia	The upper part of the shaft of the radius, reaching from the neck to the oblique line, and from the anterior border of the bicipital tubercle round to the posterior border	Posterior interosseous
Pronation	Pronator radii teres	From the common flexor tendon on the internal condyle of the humerus, the lower part of the ridge above the inter-muscular septa and the deep fascia, and a slip from the inner side of the coronoid process of the ulna	The rough oval impression half-way down the outer surface of the shaft of the radius	Median
	Pronator quadratus	From the lower fourth of the ventral surface of the ulna	The outer border of the lower fourth of the ventral surface of the radius	Anterior interosseous

The *Triangular Fibro-Cartilage* separates the two joints; it is attached by its apex to the outer surface of the styloid process of the ulna, and by its base to the edge of the inner surface of the lower end of the radius below its articulation with the ulna.

Ligaments.—The capsule is very imperfect, consisting of a few transverse fibres which connect the bones ventrally and dorsally.

The *synovial membrane* lines the joint and passes over the upper surface of the triangular fibro-cartilage.

The *Interosseous Membrane* is a strong fibrous membrane stretched between the radius and ulna, and attached to their interosseous borders. Above, it extends to within about an inch of the head of the radius, leaving a gap for the passage of the dorsal interosseous vessels; below, it reaches down to the extremities of the bones. The direction of the fibres is downwards from the radius to the ulna.

The **Wrist (Radio-Carpal) Joint** between the distal end of the radius and the triangular fibro-cartilage, and the proximal row of carpal bones.

The joint is a condyloid one, capable of movement through two axes:

Antero-posterior—flexion and extension.

Transverse—abduction and adduction.

In the ordinary position of the hand the end of the radius and articular disc are in contact with the scaphoid and semilunar bones, but in adduction (the hand bent to the ulnar side) the cuneiform bone is pushed outward and comes in contact with the triangular fibro-cartilage instead of the capsule of the joint.

Ligaments.—A *capsule* completely surrounds the joint, and is attached to the edges of the articular surfaces, and is carried up to the edge of the lower end and styloid process of the ulna. It has well-defined strengthened portions.

Anterior Carpal ligament, attached above, to the lower edge of the radius, the styloid process of the ulna, and the anterior border of the triangular fibro-cartilage; below, to the palmar surfaces of the scaphoid, semilunar, and cuneiform bones. Some fibres may be carried on to the os magnum.

Posterior-carpal ligament, attached above to the lower end of

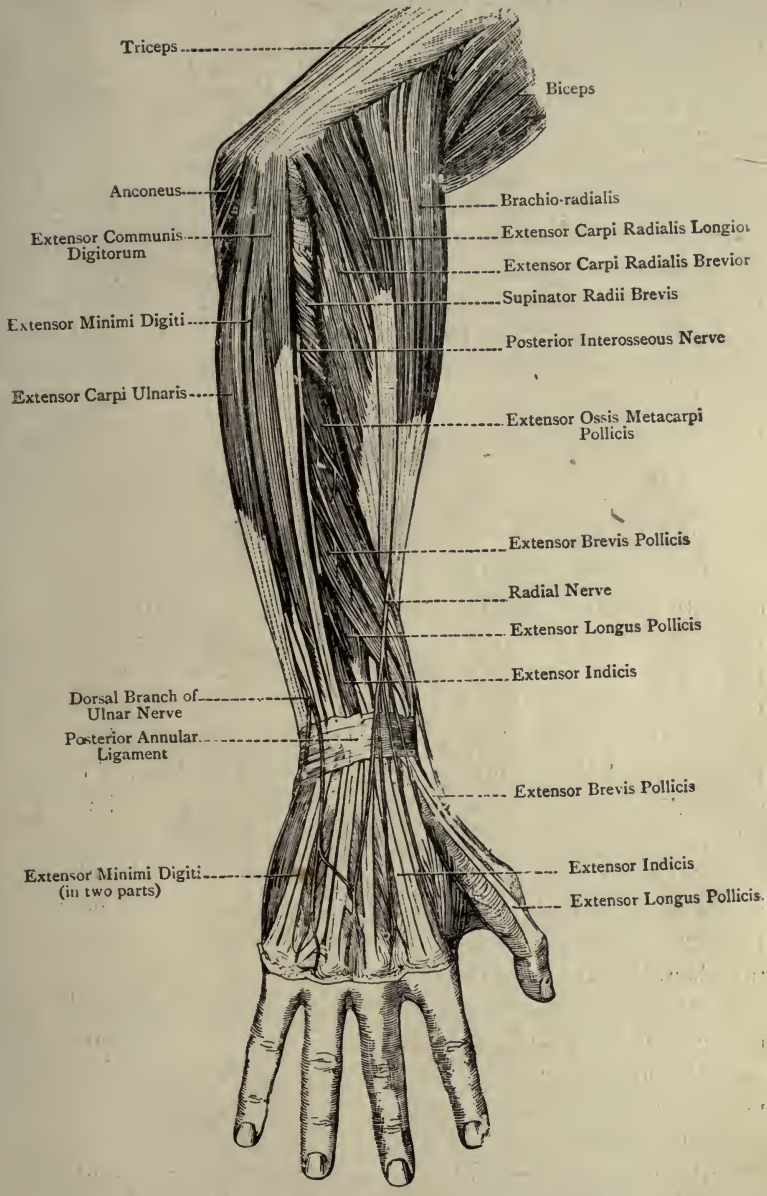


FIG. 9.—MUSCLES OF THE FOREARM (DORSAL ASPECT).

the radius and below to the dorsal surfaces of the proximal row of bones.

Internal Lateral ligament, attached above to the styloid process of the ulna, and below to the ulnar side of the cuneiform and pisiform bones.

External Lateral ligament, attached above to the styloid process of the radius, and below to the tubercle of the scaphoid.

The *synovial membrane* completely lines the joint cavity, and may be continuous with that of the inferior radio-ulnar joint if the articular disc be perforated.

The **Intercarpal Joints** between the bones of the carpus are all gliding joints, and they have numerous ligaments between the adjacent bones; in addition to this, the carpus is surrounded by a complete capsule.

The *synovial membrane* lines the joint, and may have a separate division for the articulation between the cuneiform and pisiform bones.

Muscles acting on the Joint.—These both ventrally and dorsally are arranged in two sets, superficial and deep; on the flexor (ventral) surface, the superficial group comes from the inner condyle of the humerus, and the deep ones from the ventral surfaces of the ulna and radius; on the extensor (dorsal) surface the superficial group comes from the outer condyle of the humerus, and the deep ones from the dorsal surfaces of the ulna and radius. Thus both superficial groups act on the elbow-joint.

The **Carpo-Metacarpal Joints,** between the five metatarsal bones and the distal row of carpal bones; the first metatarsal bone articulates with the trapezium, and the four inner metatarsals articulate with the other three bones.

First Carpo-Metacarpal Joint, between the base of the first metacarpal bone and the distal surface of the trapezium. The articulating surfaces of the joint are saddle-shaped, so that movements occur round three axes.

Transverse—flexion and extension.

Antero-posterior—abduction and adduction (to middle line of hand).

Longitudinal—rotation.

Although this is not a ball-and-socket joint, a certain amount of circumduction is possible, and the movement of opposition—*i.e.* bringing the thumb right across the hand—is due to a combination of flexion, adduction, and rotation.

Ligaments.—A *capsule* surrounds the joint which has strengthening bands in it, forming four ligaments.

The *synovial membrane* lines the joint, which is quite separate and distinct.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Flexor carpi radialis	From common tendon on inner condyle of humerus and deep fascia	Palmar surfaces of base of second metacarpal bone and a small slip to third metacarpal	Median
	Palmaris longus	From common tendon and deep fascia	Surface of anterior annular ligament and central part of palmar fascia	Median
	Flexor carpi ulnaris	From common tendon on inner condyle and deep fascia, the inner border of the olecranon process, and the upper three-fifths of the posterior border of the ulna	To the pisiform bone, and continued on to the hook of the unciform and the base of the fifth metatarsal	Ulnar
	Flexor sublimis digitorum	From the common flexor tendon; the internal lateral ligament of the elbow-joint and deep fascia; the inner border of coronoid process of ulna (above that of pronator radii teres); the oblique line of the radius	The muscle divides into four tendons; these split to allow the tendon of flexor profundus digitorum to pass through, and, after uniting again, each tendon divides into two parts to be inserted into the sides of the second phalanges of the four inner metatarsals	Median
	Flexor profundus digitorum	From the upper two-thirds of the anterior and internal surfaces of the ulna up to the inner surface of the olecranon process; inner half of middle third of the interosseous membrane and deep fascia	The muscle divides into four tendons, each of which passes through the corresponding tendon of flexor sublimis digitorum to be inserted in the bases of the terminal phalanges of the four inner metatarsals (see Lumbricales)	Ulnar and anterior interosseous (median)

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion (*contd.*)	Flexor longus pollicis	From the middle half of the anterior surface of the shaft of the radius and the corresponding half of the interosseous membrane	The palmar surface of the base of the terminal phalanx of the thumb	Anterior interosseous
Extension	Extensor carpi radialis longior	From the ventral surface of the lower third of the outer supracondyloid ridge of the humerus, the intermuscular septum, and the common extensor tendon on the outer condyle	The dorsal surface of the base of the second metacarpal bone	Musculospiral
	Extensor carpi radialis brevior	From the common extensor tendon, the external lateral ligament of the elbow-joint and deep fascia	The dorsal surface of the base of the third metacarpal bone	Posterior interosseous
	Extensor communis digitorum	From the common extensor tendon and deep fascia	The muscle divides into four tendons, to be inserted in the four inner digits. Each one passes down the back of the hand and spreads out over the knuckle; it then divides into three slips—the middle one is inserted into the base of the second phalanx, and the side ones join together to be inserted into the base of the terminal phalanx	Posterior interosseous
	Extensor minimi digiti	From the common extensor tendon and deep fascia	Into the expansion of the extensor tendon on the back of the first phalanx of the little finger	Posterior interosseous
	Extensor carpi ulnaris	From the common tendon and deep fascia and middle half of the posterior border of the ulna	The ulnar side of the base of the fifth metacarpal bone	Posterior interosseous
	Extensor ossis metacarpi pollicis	From the upper half of the outer surface of the ulna; the middle third of the dorsal surface of the radius and interosseous membrane	The radial side of the base of the first metacarpal	Posterior interosseous

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Extension (*contd.*)	Extensor brevis pollicis	From the dorsal surface of the radius below extensor ossis metacarpi pollicis and the interosseous membrane	The dorsal surface of the base of the first phalanx of the thumb	Posterior interosseus
	Extensor longus pollicis	From the middle third of the dorsal surface of the ulna and the interosseous membrane below extensor ossis metacarpi pollicis	The dorsal surface of the base of the second phalanx of the thumb	Posterior interosseous
	Extensor indicis	From the dorsal surface of the ulna below extensor longus pollicis and from the interosseous membrane	The expansion of the tendon of extensor communis digitorum on the first finger	Posterior interosseous
Abduction	Flexor carpi radialis	See Flexion		
	Extensors carpi radialis longior and brevior	See Extension		
	Extensors of thumb	See Extension		
Adduction	Flexor carpi ulnaris	See Flexion		
	Extensor carpi ulnaris	See Extension		

The other carpo-metacarpal joints are formed between the bases of the four inner metacarpals and the trapezoid, os magnum, and unciform. They are freely moving gliding joints.

Ligament.—A common capsule surrounds all four joints, which includes also the intermetacarpal joints. There are numerous interosseous ligaments binding them all together.

A *synovial membrane* lines all the joint cavities, which communicate with one another.

Metacarpo-Phalangeal Joints are between the heads of the metacarpal bones and the bases of the first phalanges.

The first one differs from the rest in being a hinge-joint ; the others are modified ball-and-socket, so that movement takes place round two axes :

Transverse—flexion and extension.

Antero-posterior—abduction and adduction.

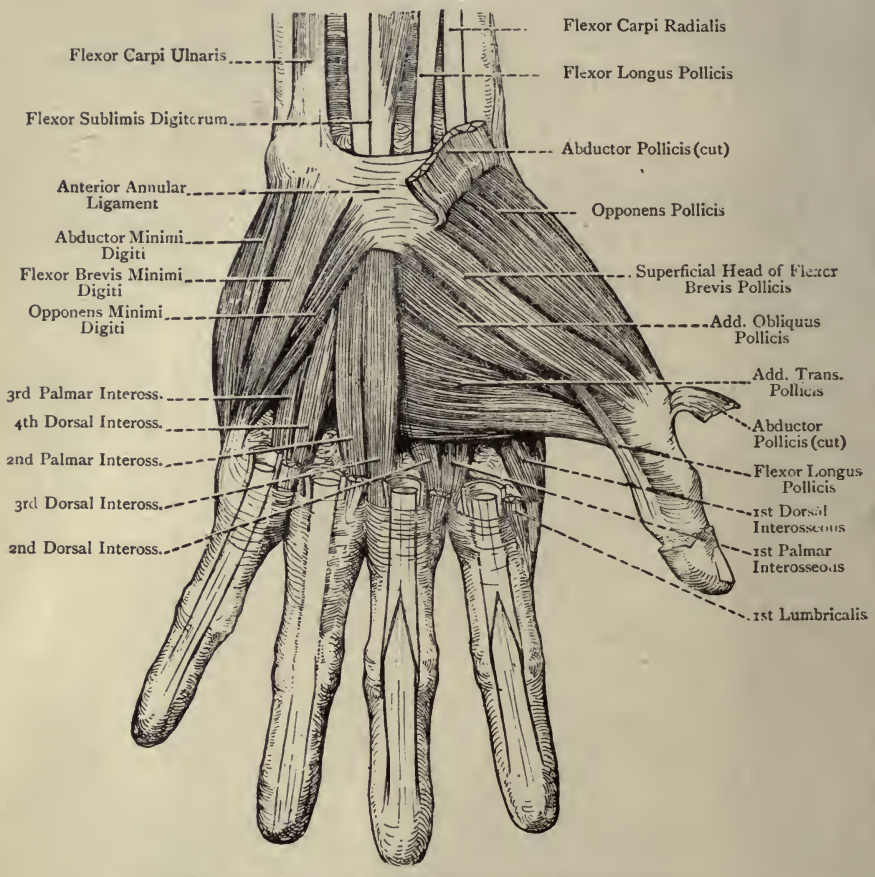


FIG. 10.—MUSCLES OF THE HAND (PALMAR ASPECT).

Ligaments.—A *capsule* completely surrounds each joint, which is very much weaker on the dorsal surface, where the joint is strengthened by the expansion of the extensor tendon.

Ulnar and Radial Lateral ligaments, strong cord-like bands

attached to the tubercles on the sides of the heads of the metacarpal bones and the bases of the phalanges.

The *Palmar* ligaments are plates of fibro-cartilage attached firmly to the phalanges, but only loosely to the metacarpals, so that during movements of the joints they can glide up and down. In this plate two sesamoid bones are developed in the thumb, and one on the radial side of the forefinger.

Synovial membrane lines the capsule of each joint.

Transverse Metacarpal ligament consists of bands of transverse fibres, which connect the palmar ligaments of the four inner metacarpo-phalangeal joints. This binds together the distal extremities of the bones.

Interphalangeal Joints.—These joints are all hinge-joints, allowing movements round one axis only:

Transverse—flexion and extension.

Their ligaments and synovial membrane are similar to those of the metacarpo-phalangeal joints.

MUSCLES ACTING ON THE JOINTS.

FIRST METACARPO-PHALANGEAL AND INTERPHALANGEAL JOINT.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Flexor longus pollicis	See Wrist-Joint		
	Flexor brevis pollicis	1. Radial half lower border anterior annular ligament and the ridge on the trapezium	Radial side base of first phalanx	Median
		2. Ulnar side of base of first metacarpal	Ulnar side of base of first phalanx	Ulnar
	Abductor brevis pollicis	From the tubercle of the scaphoid, the ridge of the trapezium, the radial part of the anterior surface of the annular ligament	The radial side of the base of the first phalanx and the capsule of the joint	Median
	Opponens pollicis	From the ridge on the trapezium and the anterior surface of the annular ligament	The whole of the radial border and the radial half of the palmar surface of the first metacarpal	Median

FIRST METACARPO-PHALANGEAL AND INTERPHALANGEAL JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
	Adductor obliquus pollicis	From the palmar surfaces of the os trapezium and trapezoid, the os magnum and bases of the second, third, and fourth metacarpals	The ulnar side of the base of the first phalanx	Ulnar
	Adductor transversus pollicis	From the lower two-thirds of the median ridge on the palmar surface of the third metacarpal	The ulnar side of the base of the first phalanx	Ulnar
Extension	Abductor longus pollicis	See Wrist-Joint		
	Extensor longus pollicis	See Wrist-Joint		
	Extensor brevis pollicis	See Wrist-Joint		
Adduction	Adductor obliquus pollicis	See Flexion		
	Adductor transversus pollicis	See Flexion		
	Flexor brevis pollicis	See Flexion		
	Opponens pollicis	See Flexion		
	First dorsal interosseous	From the adjacent sides of the first and second metacarpal bones	The radial side of the index-finger on the dorsal expansion of the extensor tendon, the capsule of the metacarpo-phalangeal joint and the side of the first phalanx	Ulnar
Abduction	Abductor brevis pollicis	See Flexion		
	Abductor longus pollicis	See Wrist-Joint		
	Extensors of thumb	See Wrist-Joint		
Circumduction and rotation are carried out by a combination of these muscles				

METACARPO AND INTERPHALANGEAL JOINTS OF FOUR INNER DIGITS.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Flexor sublimis digitorum	See Wrist-Joint		
	Flexor profundus digitorum	See Wrist-Joint		
	Lumbricales	Four muscles arising from the tendons of flexor profundus digitorum		
	Two radial ones	From the radial sides of the tendons for the index and middle fingers	Similar to the dorsal interosseous muscle. See Thumb-Joints	Median
	Two ulnar ones	From the adjacent sides of the second and third, and third and fourth tendons	Similar to the dorsal interosseous muscle. See Thumb-Joints	Ulnar
	Interossei palmar	Three ; the first from the ulnar side of the second metacarpal, the two others from the radial side of the fourth and fifth metacarpals respectively	Ditto	Ulnar
	Dorsal	Four, each arising from the adjacent sides of the metacarpal bone	Ditto	Ulnar
On the	*fifth finger*	*only :*		
	Flexor brevis minimi digiti	From ulnar part of anterior surface of annular ligament and hook of unciform	Ulnar side of base of first phalanx of little finger	Ulnar
Extension	Extensor communis digitorum	See Wrist-Joint		
	Extensor indicis	See Wrist-Joint		
	Extensor minimi digiti	See Wrist-Joint		
	Lumbricales	See Flexion		
	Interossei	See Flexion		

METACARPO AND INTERPHALANGEAL JOINTS OF FOUR INNER DIGITS—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Abducti	on *from the*	*ulnar side of the hand*		
	Lumbricales	See Flexion		
	Flexor brevis minimi digiti	See Flexion		
	Opponens minimi digiti	Similar to flexor brevis minimi digiti	The lower three-fourths of the ulnar margin and palmar surface of the fifth metacarpal	Ulnar
From	*the middle*	*line of the middle finger:*		
	Dorsal interossei	See Flexion		
	Abductor minimi digiti	From the palmar surface of the pisiform bone	Ulnar side of base of first phalanx of little finger	Ulnar
Adducti	on *to the*	*middle line of the middle*	*finger*	
	Palmar interossei	See Flexion		

The **Deep Fascia** of the shoulder and upper limb is attached to the clavicle, acromion, and spine of scapula. It encases all the muscles, and is continuous with the deep fascia of the back and the axilla; it is then continued down the arm, covering all the muscles, and at the elbow sends in processes called intermuscular septa, which separate the muscles of the front of the arm from those of the back, also affording additional surface for the origins of muscles. In front of the elbow it is attached to the condyles of the humerus and olecranon process of the ulna, and covers in the antecubital fossa, and receives a crescent-shaped expansion from the tendon of the biceps called the bicipital fascia; it is continued down the forearm, closely investing the muscles and sending septa between them. At the wrist, on both dorsal and ventral surfaces, there are bands of strong transverse fibres to hold down the tendons, called respectively, posterior and anterior annular ligaments of the wrist-joint. The deep fascia then invests the muscles of the hand forming anteriorly a particularly strong triangular piece—the palmar fascia—which sends four processes to be inserted into the digital sheaths.

Costo-Coracoid Membrane, a process of the deep fascia covering pectoralis minor, which, after splitting to enclose subclavius, becomes attached to the first costal cartilage and the coracoid process. The membrane itself is thin and pierced by superficial vessels, but the piece between the costal cartilage and coracoid process is much stronger, and is called the costo-coracoid ligament.

Axillary Fascia, a particularly strong fascia forming the floor of the axillary space, from the edge of the pectoralis major in front to the latissimus dorsi and teres major behind; it is continuous with the deep fascia of the arm.

Bicipital Fascia, a strong band of fascia from the tendon of the biceps, which joins the deep fascia covering the front of the elbow. It separates the brachial artery from the median basilic vein.

Anterior annular ligament, a band of transverse fibres in the deep fascia attached on the ulnar side to the pisiform bone and the hook of the unciform, and on the radial side to the scaphoid and trapezium. It bridges across the concavity of the carpus and holds the flexor tendons in place. All the tendons pass under it, except palmaris longus and flexor carpi radialis, the latter piercing the ligament to reach its insertion. The ulnar artery and nerve cross over the ligament.

Posterior annular ligament, a transverse band of fibres in the deep fascia, attached to the external border of the lower end of the radius, and the internal border of the lower end of the ulna. This is a much weaker and less important band than the anterior one. All the tendons pass underneath it, the ulnar and radial nerves passing over it.

The fascia is divided underneath into six compartments for the passage of the tendons, which lie in grooves in the bone.

1. Extensor ossis metacarpi pollicis
   Extensor brevis pollicis
   } in the first groove on the external side of the radius.
2. Extensor carpi radiales, longior and brevior } in the second groove.
3. Extensor longus pollicis in the third groove.

4. Extensor communis digitorum
   Extensor indicis
   } in the fourth groove.
5. Extensor minimi digiti in the groove between the ulna and radius.
6. Extensor carpi ulnaris in the groove of the ulna.

Digital Sheaths, strong fibrous sheaths which hold down the flexor tendon of the fingers. They are attached along the edges of the palmar surfaces of the phalanges and interphalangeal joints, and continuous with the palmar fascia.

The **Axilla** is the hollow space in the armpit through which the axillary vessels and the cords of the brachial plexus pass to reach the arm. It is cone-shaped, with the apex upwards.

The apex is bounded by the superior border of the scapula, the first rib, and the clavicle, and is covered in by the costo-coracoid membrane.

The floor is formed of the deep fascia.

The posterior wall is formed by subscapularis, teres minor, teres major, and latissimus dorsi, the lower free edge of which is called the posterior fold.

The anterior wall is formed by pectoralis major, the lower free edge of which is called the anterior fold.

The inner wall is formed by the upper digitations of the serratus magnus. The outer wall is formed by the long head of triceps and the humerus.

The contents are the axillary vessels, the cords of the brachial plexus with their branches, some lymphatic glands and fat.

The **Antecubital Fossa** is the triangular space in front of the elbow-joint, covered in by deep fascia and the bicipital fascia. Its boundaries are, above, a line drawn between the condyles of the humerus, on the inner side pronator radii teres, and on the outer side brachio-radialis.

In the fossa the brachial artery breaks up into its branches.

SECTION III

PELVIC GIRDLE AND LOWER LIMB

The pelvic girdle consists of three bones firmly joined together, with two of which the two femurs articulate by means of ball-and-socket joints; the pelvic girdle and lower limb are analogous to the shoulder girdle and upper limbs (see comparison in Section I.).

The bones forming the pelvis are the two innominate bones, joined together in front at the symphysis pubis and articulating with the sacrum behind.

The **Innominate Bone** is a large, flat irregular-shaped bone consisting of three parts, which at birth are distinct, but in adult life become fused together in the same way that epiphyses fuse with the shafts in long bones. The three parts are respectively the ilium, ischium, and pubis, which join together to form the acetabulum, a deep socket which receives the head of the femur.

The **Ilium** forms a fan-shaped expansion, the top edge of which, the crest of the ilium, is thickened to give attachment to muscles. About two inches from the anterior end is a rough tubercle, which is the highest point of the crest, and can easily be felt in the living subject. The crest forms an **S**-shaped curve, the anterior half being convex outwards. The ends are termed respectively the anterior and posterior superior spines. The anterior margin of the ilium extends from the anterior superior spine to the margin of the acetabulum, of which the ilium forms the upper two-fifths. Halfway down the anterior margin is a rough tubercle called the anterior inferior spine.

The posterior margin extends from the posterior superior spine to the posterior margin of the acetabulum. A little way

below the spine is another tubercle, called the posterior inferior spine; from this the edge of the bone curves sharply forwards, forming the great sciatic notch.

The ilium has two surfaces—internal and external. The external one is sometimes termed the gluteal, as it has three

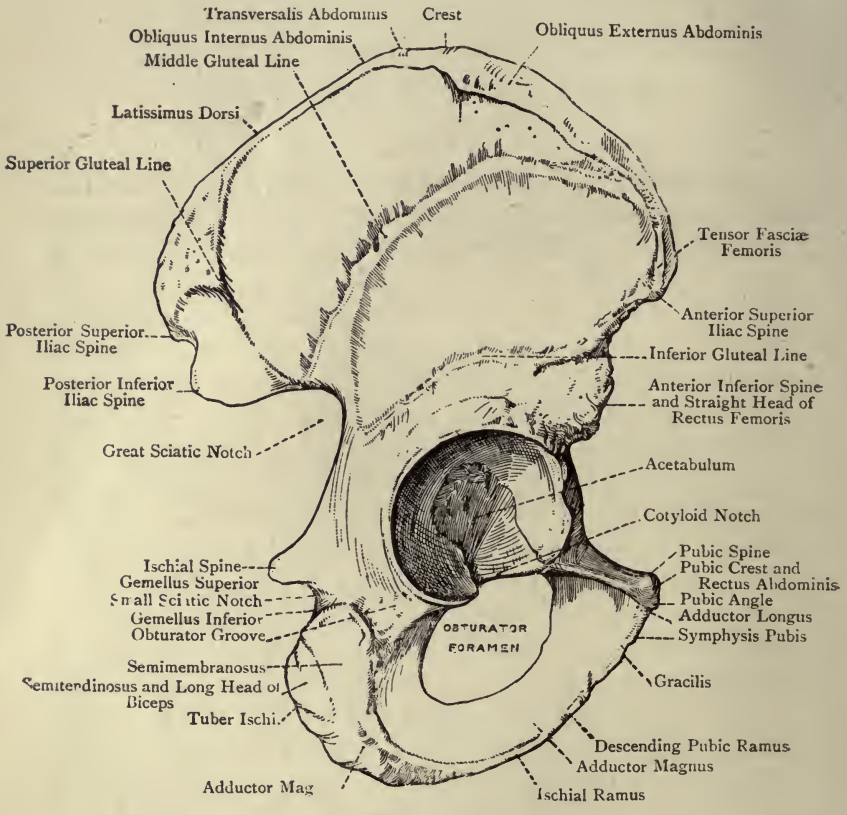


FIG. 11.—INNOMINATE BONE.

well-marked ridges—superior, middle, and inferior—which limit the origins of the gluteal muscles. The internal surface of the bone is divided into two parts—the posterior part, which takes up nearly half, is a rough auricular-shaped surface for articulation with the sacrum; while the anterior part, which is

smooth, has a sharp well-defined oblique ridge, the ilio-pectineal line, from the auricular surface to the front of the bone. This marks the line of fusion with the pubis, and also divides the true pelvis from the false pelvis. Above the ilio-pectineal line the bone forms the shallow iliac fossa.

The **Ischium** consists of a body and two rami—superior and inferior. The body forms the inferior and posterior two-fifths of the acetabulum, and from the posterior border of the body projects a sharp spine—the ischial spine. From the body the superior ramus passes downwards and back, and from its inferior extremity the inferior ramus passes forwards at an acute angle, to join the inferior ramus of the pubis. The angle of the two ischial rami forms a large tubercle — the tuberosity of the ischium—and between this and the ischial spine above, the edge of the bone is curved forwards to form the small sciatic notch.

The **Pubis** consists of a small triangular body with two rami—superior and inferior. The superior ramus completes the remaining one-fifth of the acetabulum, and the inferior ramus passes backwards to join the inferior ramus of the ischium, thus enclosing the obturator, or thyroid foramen. The upper part of the body projects forwards to form the crest of the pubis, which externally ends in a small spine or tubercle which joins the ilio-pectineal line. The inner border of the body consists of a long, narrow, oval surface which articulates with its fellow of the opposite side by means of an intermediate disc of cartilage.

The **Acetabulum** is practically half a sphere, and is directed downwards and forwards. It has a sharp, well-defined margin, which is interrupted inferiorly, forming the cotyloid notch.

Ossification.—At birth there are three primary centres, one in each bone. Afterwards secondary centres appear for the ischial tuberosity and spine, and inner part of the body of the pubis. The whole bone is usually fused together by the twenty-fifth year.

The **Sacrum,** articulating with the innominate bones, completes the pelvis. (For description of sacrum, see the Vertebræ, in Section IV.)

The **Pelvis** is divided into two parts by the ilio-pectineal line, which extends from the sacro-iliac joint behind to the spine of

the pubis in front. The part above this line is called the false pelvis; the part below, the true pelvis.

The false pelvis is bounded by the expanded wings of the ilium and the upper part of the sacrum, and supports the abdominal contents. The true pelvis is much smaller, and is bounded above by the ilio-pectineal lines and the upper margin of the pubis, and its walls are formed by the lower part of the sacrum, the bodies and rami of the ischium and pubis.

Differences between Male and Female Pelvis.—The upper margin of the true pelvis is often called the brim, or inlet, of

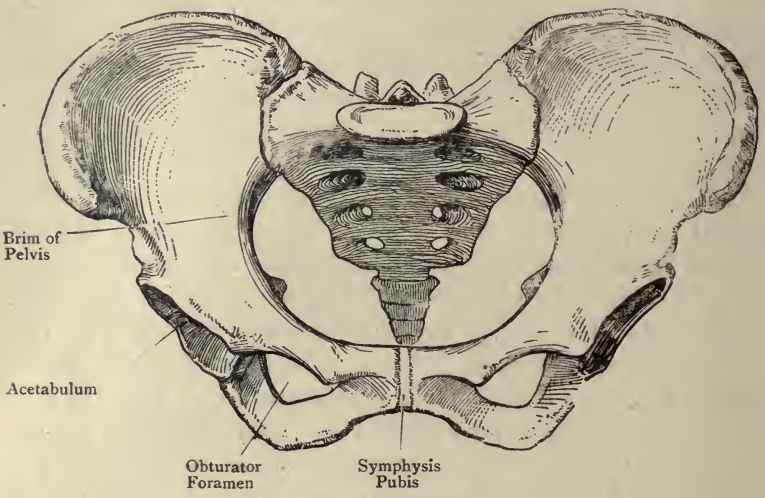


FIG. 12.—PELVIS.

the pelvis. This is heart-shaped in the male and oval in the female owing to the shape of the upper part of the sacrum, which in the male is more prominent.

The angle formed by the bodies of the two pubic bones at the symphysis—*i.e.*, the pubic arch—is a right angle in the female and an acute angle in the male. The ischial spines are turned inwards in the male and project straight from the ischium in the female.

The coccyx is turned forwards in the male and as a rule firmly joined to the sacrum. In the female it is straighter and has a movable joint.

From these differences it will be seen that the true pelvis is altogether more roomy in the female and the outlet wider, which is necessary for the purposes of childbirth.

The **Femur** is a long bone with a shaft and two extremities. It articulates above with the acetabulum of the os innominatum and below with the head of the tibia and the patella.

The *Upper Extremity* consists of a rounded head forming half a sphere, which is joined to the shaft, at an angle of 127·5 degrees, by the neck, a stout bar of bone, an inch or more in length. The cartilage-covered part of the head has a wavy outline where it joins the neck, and just below the summit is a small fossa for the insertion of the ligamentum teres. The two trochanters of the femur are situated on the posterior aspect of the upper end of the shaft, the great trochanter being placed externally and the small trochanter internally. Where the neck joins the shaft a distinct line is seen, the intertrochanteric line in front, and behind where it is more prominent it is called the intertrochanteric ridge (crista intertrochanterica). Just above the middle of this ridge is the quadrate tubercle. The great trochanter overhangs the neck above, and in the depression thus formed is found the digital fossa for the tendon of obturator externus. On its external surface is an oblique line running from above downwards and forwards. The small trochanter is a rounded eminence confluent with the shaft below.

The *Shaft* is cylindrical in shape and convex forwards, increasing in size gradually from above downwards. At its lower end it is flattened to support the condyles. The shaft is smooth except on its posterior surface, where a narrow longitudinal ridge is found—the linea aspera. This has distinct inner and outer lips, which separate inferiorly, each passing down to its own condyle and enclosing a smooth triangular space—the popliteal surface. Where the inner lip meets the condyle is a small tubercle—the adductor tubercle.

The *Lower Extremity* of the femur is flattened and recurved posteriorly to form two condyles, between them being the deep intercondylic notch. In front they are united to form a smooth, flat surface for the patella. The inner condyle is longer and narrower than the outer one; but as the femur in its normal

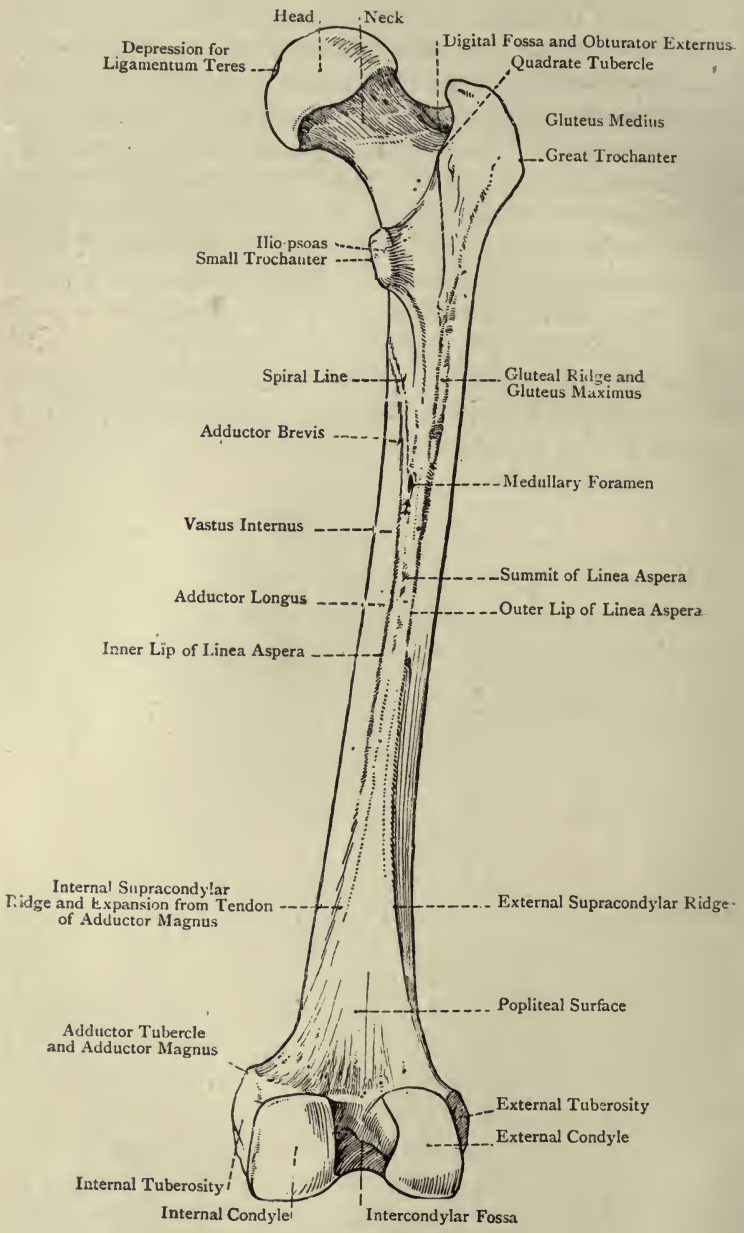

Head
Neck
Depression for Ligamentum Teres
Digital Fossa and Obturator Externus
Quadrate Tubercle
Gluteus Medius
Great Trochanter
Ilio-psoas
Small Trochanter
Spiral Line
Gluteal Ridge and Gluteus Maximus
Adductor Brevis
Medullary Foramen
Vastus Internus
Summit of Linea Aspera
Adductor Longus
Outer Lip of Linea Aspera
Inner Lip of Linea Aspera
Internal Supracondylar Ridge and Expansion from Tendon of Adductor Magnus
External Supracondylar Ridge
Popliteal Surface
Adductor Tubercle and Adductor Magnus
External Tuberosity
External Condyle
Internal Tuberosity
Internal Condyle
Intercondylar Fossa

FIG. 13.—FEMUR.

position is placed obliquely—*i.e.*, the upper extremities being widely separated by the pelvis—while the lower extremities are in apposition to one another, the inferior surfaces normally are in the same horizontal plane; whereas if the femur is held vertically, the inner condyle projects downwards below the outer one. The inner surface of the inner condyle and the outer surface of the outer condyle are subcutaneous, and each possesses a pronounced tuberosity for the attachment of ligaments.

The *Inferior Surface* of the femur is cartilage covered for articulation with the head of the tibia. It is more or less crescentic in form, the convexity being forwards. The anterior part is called the trochlea, and articulates with the patella. The inferior surfaces of the condyles are convex in both directions. That of the outer one is wider than the inner, and rises to a higher point on the anterior surface of the shaft. They each articulate with the tibia by means of a meniscus of cartilage, which separates the bones from one another.

Ossification.—There is one primary centre for the shaft before birth, secondary centres appearing for the head, trochanter and lower extremity. (This latter may appear just before birth.) The whole bone is fused together by the twenty-second year.

The **Patella** is the largest sesamoid bone in the body, and is formed in the tendon of the quadriceps extensor in front of the knee-joint. It is triangular in shape, with the apex downwards. The anterior surface of the bone is slightly convex. The posterior surface is much more rounded, and has a ridge which divides it into two parts longitudinally, of which the inner one is the smaller. This ridge glides between the two condyles of the femur.

Ossification.—The patella does not begin to ossify till about the third year, and is complete at puberty.

The **Tibia** is the inner bone of the leg. It is a long bone with a shaft and two extremities, and articulates above with the condyles of the femur and the upper end of the fibula; below, with the lower end of the fibula and one tarsal bone, the astragalus.

The *Upper Extremity* is much expanded, and forms two

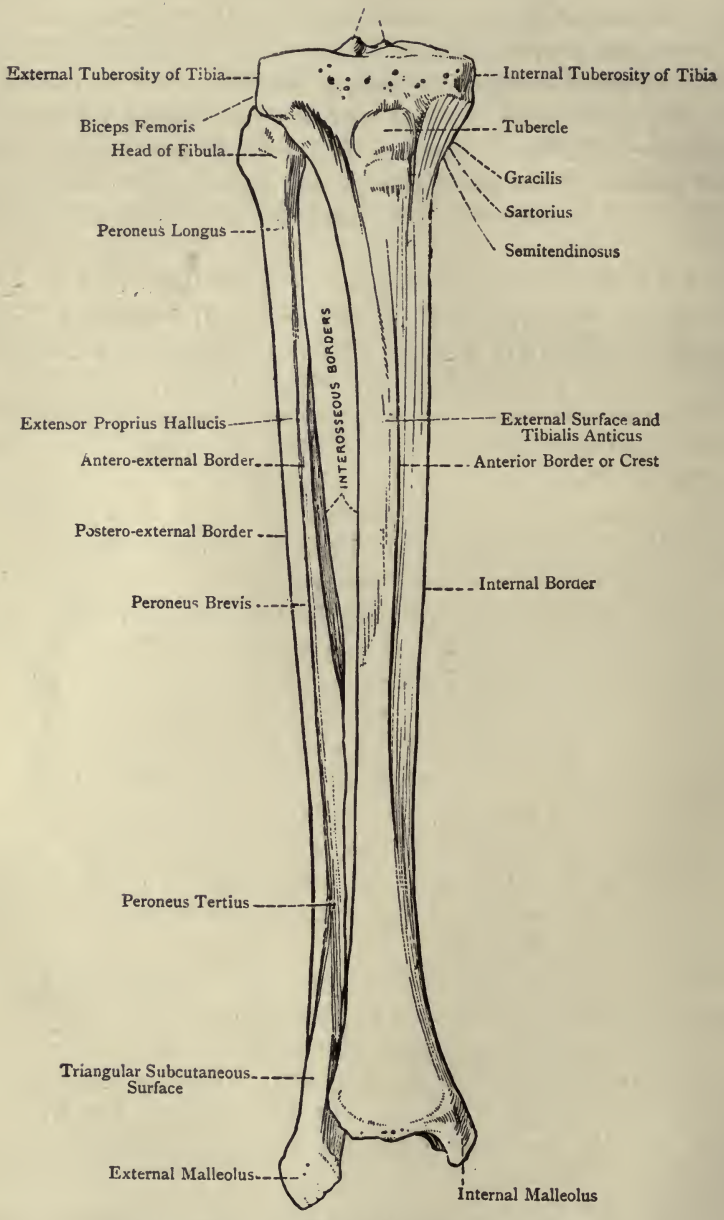


FIG. 14.—TIBIA AND FIBULA (ANTERIOR SURFACES).

tuberosities to support the condyles of the femur. The outer one somewhat overhangs the shaft. On the upper aspects of these are two smooth semicircular surfaces for the articular menisci, and between them in the centre a rough elevation, the intercondyloid spine. Where the outer tuberosity overhangs the shaft is a small articular facet for the head of the fibula. On the posterior surface of the inner tuberosity is a short horizontal groove for the semimembranosus muscle. In front of the lower part of the two tuberosities is a large tubercle, the upper half of which is smooth and covered by a bursa; the lower, rough, for the attachment of the ligamentum patellæ.

The *Shaft* is triangular in shape, having an anterior, internal, and external borders, and internal, external, and posterior surfaces. The anterior border is sharp and subcutaneous, forming what is known as the shin. The internal surface is also subcutaneous, except in its upper fourth. On the posterior surface is seen the oblique, or popliteal, line, which runs from the outer tuberosity to the internal border at the junction of the upper and middle thirds. The posterior surface is divided into two parts by a vertical line dropped from the middle of the oblique line.

The *Lower Extremity* is expanded and becomes quadrilateral. The external surface has a large articular area for the lower end of the fibula, and the internal surface is continued downwards into a triangular process, called the internal malleolus, whose outer surface is confluent with the inferior surface of the shaft, and articulates with the astragalus. On the posterior surface just external to the malleolus there are two grooves for the passage of tendons.

Ossification.—At birth the shaft is almost completely ossified, and a centre has appeared in the upper extremity. Very early the centre appears for the lower extremity, and the whole bone is fused together by the twenty-fourth year.

The **Fibula** is a long, slender bone on the outer side of the leg. It articulates above with the outer tuberosity of the tibia, and below with the lower end of the tibia and the outer surface of the astragalus.

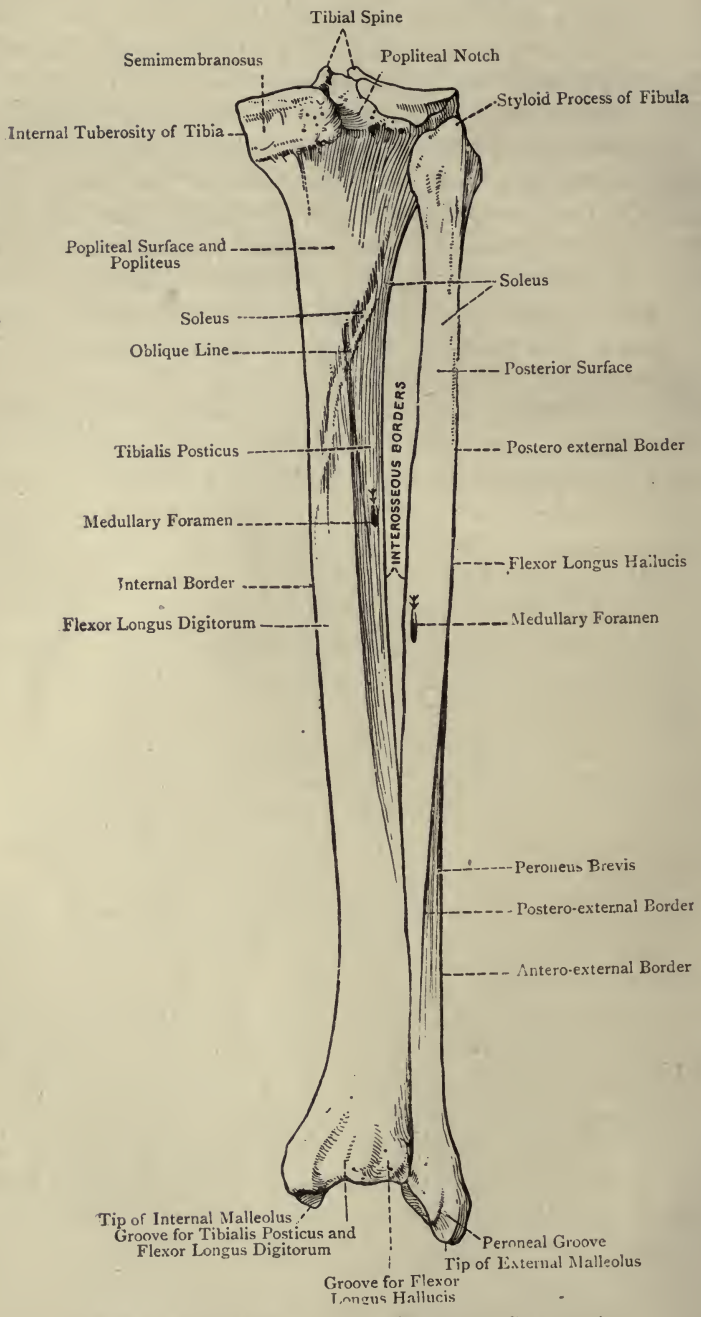


FIG. 15.—TIBIA AND FIBULA (POSTERIOR SURFACES).

The *Upper Extremity* is irregularly rounded, and has on its internal surface a facet for articulation with the tibia, and just above this is a pointed process—the styloid process.

The *Shaft* is very irregular in shape and twisted on itself, but a very narrow anterior surface can be distinguished between the interosseous and external borders. The external border splits below to form a triangular subcutaneous area on the outer malleolus, and behind this line is the external surface. The surface next the external surface is the posterior surface, which is divided by a sharp ridge. (This ridge may be mistaken for the interosseous ridge, but that can be determined by following up the line from the triangular surface on the malleolus. This line is the external border of the anterior surface.)

The *Lower Extremity* is flattened and expanded to form the external malleolus, on the internal surface of which is the facet for articulation with the outer surface of the astragalus. Just behind this facet is the digital fossa for the insertion of a ligament.

Ossification is similar to that of the tibia, except that the centre for the shaft is the only one that appears before birth.

The **Tarsus** is composed of seven bones—the astragalus, os calcis, scaphoid, cuboid, and three cuneiforms.

The **Astragalus** is the uppermost bone, and, articulating with the tibia and fibula, supports the weight of the body. It is of irregular cubical form, and on the upper, inner, and outer surfaces is one large confluent articular facet, fitting into the space enclosed by the under surface of the tibia, and the two malleoli. This facet is saddle-shaped, and is broader in front than behind. Anteriorly is a somewhat constricted neck supporting the rounded head, which articulates with the scaphoid bone. On the inferior surface is a large concave facet for articulation with the os calcis. A deep groove divides this facet into two parts, the anterior part articulating with the sustentaculum tali, while the posterior part rests on the body of the os calcis. A strong interosseous ligament is inserted in this groove. Posteriorly the bone is divided by a groove, oblique from above downwards and inwards, into two tubercles. In the groove runs the tendon of tibialis posticus.

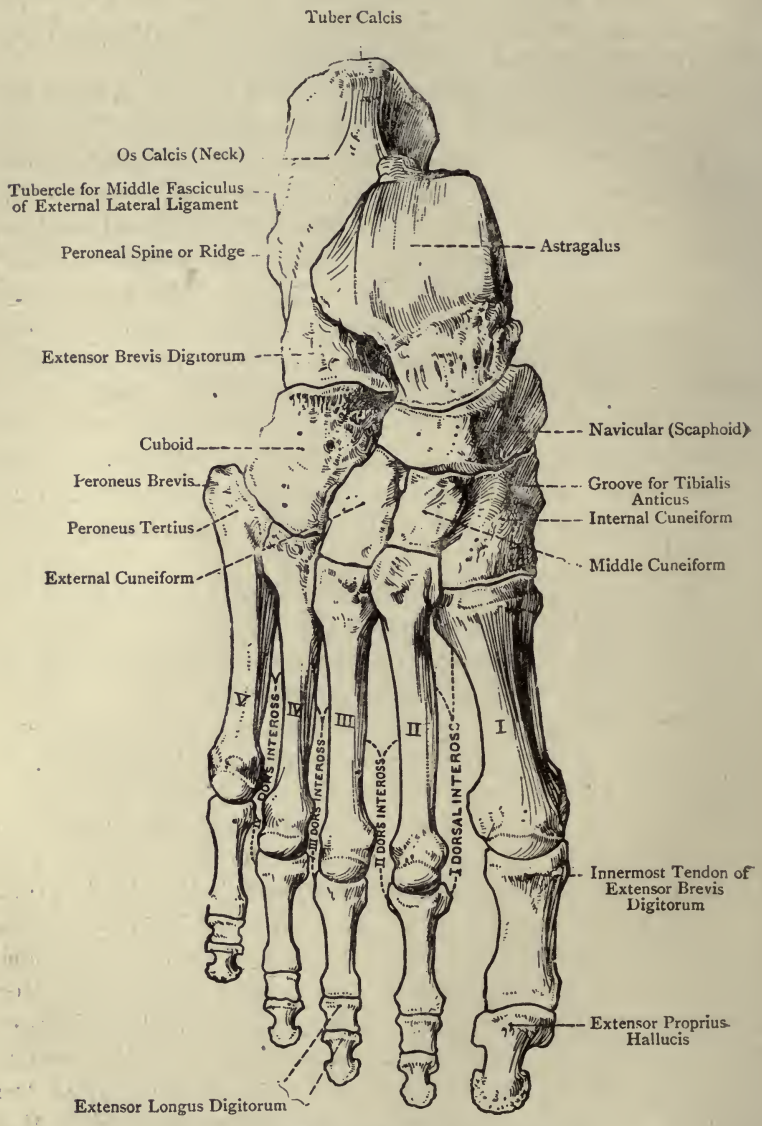


FIG. 16.—BONES OF FOOT (DORSAL SURFACE).

The **Os Calcis** is the largest bone of the tarsus. It is roughly cubical, with a projection posteriorly, forming the heel. The upper surface has anteriorly two facets, divided by a groove to correspond with the facets on the under surface of the astragalus. On the outer side of the anterior facet is a rough surface for muscular origins. The anterior surface has a smooth, convex surface articulating with the cuboid bone. Posteriorly, the tuberosity, which is confluent with the body of the bone, has a surface divided into three parts. The upper part is smooth and covered by a bursa, the middle portion is roughened for the attachment of the tendo Achillis, and the lower part is rough and confluent with the inferior surface. On the inner surface of the body is the sustentaculum tali, a stout projection of bone supporting the astragalus. On the outer surface is the peroneal spine, a small tubercle separating the tendons of peroneus longus and brevis.

The plantar surface is slightly concave from before backwards, and roughened for the attachment of muscles and ligaments. Posteriorly, there are two tubercles, of which the inner one is the larger.

The **Scaphoid** is a flat, oval bone, compressed from before backwards, the long axis being horizontal. It articulates posteriorly with the head of the astragalus, and anteriorly with the three cuneiform bones. The inner surface of the bone projects beyond the inner border of the foot, and forms a rounded tubercle easily felt in the living subject.

The **Cuneiform Bones** are three in number—internal, middle, and external. They articulate posteriorly with the scaphoid, and anteriorly with the first, second, and third metatarsals. They are wedge-shaped in form, with the points downwards, the first being the largest, and not so pointed inferiorly as the others. This arrangement helps to keep the concave plantar surface presented by the bones of the foot.

The **Cuboid Bone** is roughly cubical, and lying on the outer side of the foot articulates posteriorly with the anterior surface of the os calcis and anteriorly with the fourth and fifth metatarsals. On its inner side it articulates with the external cuneiform bone. On the plantar surface is an oblique ridge running

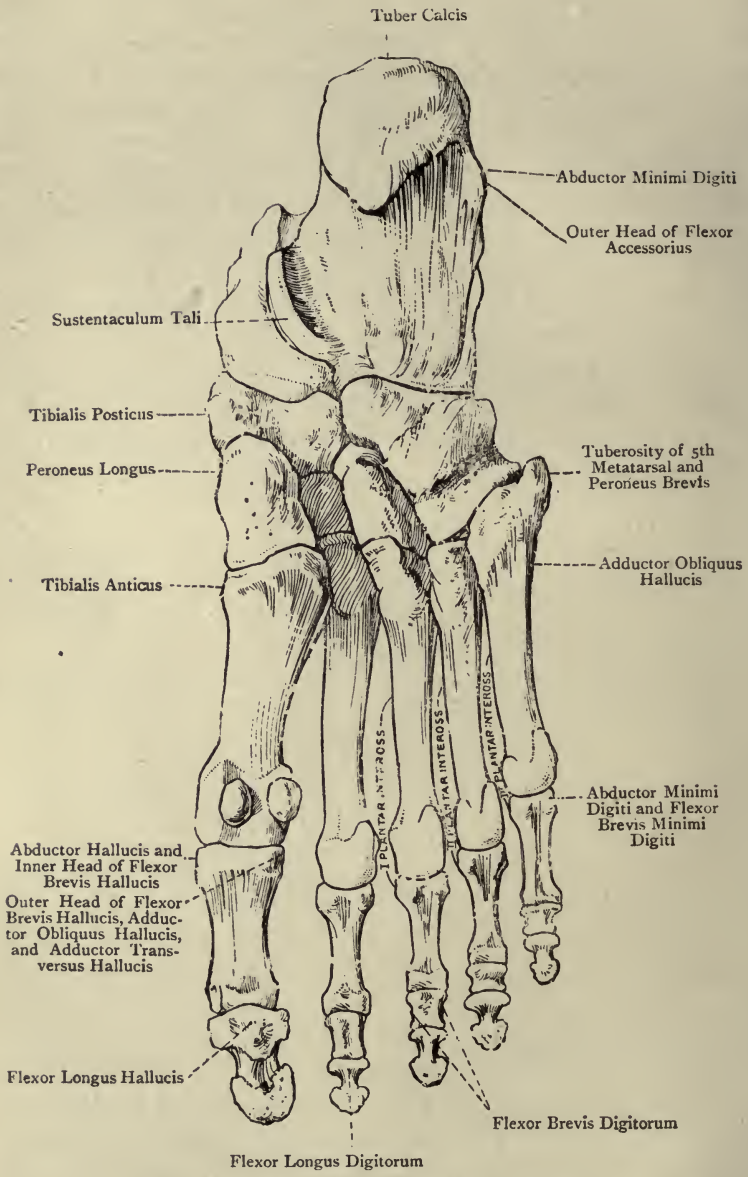


FIG. 17.—BONES OF FOOT (PLANTAR SURFACE).

from without inwards and forwards, and just in front of this a groove for the tendon of peroneus longus.

Ossification.—The astragalus and the os calcis are partially ossified at birth. The other bones commence early in life, and the tarsus is completely ossified by the twentieth year.

The **Metatarsus** resembles the metacarpus, and consists of five long bones articulating with the tarsus behind and supporting the phalanges in front.

The first metatarsal is the shortest and stoutest and the second metatarsal the longest. The fifth metatarsal has a prominent tubercle projecting backwards from the outer side of the base, which can easily be felt in the living subject. The metatarsals articulate with one another by their bases.

Ossification.—Similar to that of the metacarpus.

The **Phalanges** of the toes resemble those of the fingers in shape and number (fourteen in all). They are, however, much smaller proportionately, and in the smaller toes the second and third phalanges are often compressed to mere nodules.

Ossification.—Similar to that of the fingers.

Articulations of the Pelvis.

Lumbo-Sacral Joint.—This takes place between the fifth lumbar vertebra and the sacrum, and is similar to the other intervertebral joints. It has, however, an accessory ligament, the *lateral lumbo-sacral* ligament, which is attached to the front of the transverse process of the fifth lumbar vertebra and the front of the sacrum close to the sacro-iliac joint.

Sacro-Iliac Joint between the articulating portion of the wing of the ilium and the similar auricular surface on the sacrum. The joint surfaces are very closely applied to one another, so that movement is limited, as great stability is required rather than free movement. The joints are just movable enough to prevent absolute rigidity, and their roughened surfaces prevent gliding to any extent.

Ligaments.—A *capsular* ligament surrounds the joint, which is strengthened by transverse fibres dorsally and ventrally.

The *synovial membrane* is rudimentary.

Accessory Ligaments: The *Ilio-Lumbar* ligament extends from

the tip of the transverse process of the fifth lumbar vertebra to the iliac crest just behind its highest point. It is in reality a thickened portion of the lumbar fascia.

The *Great Sciatic Ligament* is triangular in shape. It is attached to the posterior inferior spine of the ilium, the tuberosity of the ischium, and to the posterior aspects of the lower part of the sacrum. It fills the gap between the innominate bone and sacrum, and, by completing the great and small sciatic notches, forms the great and small sacro-sciatic foramina.

The *Small Sciatic Ligament* is also triangular; it lies ventrally to the great sciatic ligament, and is attached by its base to the last two segments of the sacrum, and by its apex to the spine of the ischium.

The **Symphysis Pubis** is an immovable joint between the two pubic bones. The articular surfaces are covered with cartilage as usual, and have, in addition, an interarticular disc of cartilage welding them firmly together. There are ligaments all round the joint, the most important being the *subpubic* ligament, which is in the arch of the pubis and separated from the triangular ligament of the perineum by a small interval. The subpubic ligament is attached to the interarticular ligament and the descending rami of the pubic bones. There is no synovial membrane.

The *Triangular Ligament* of the perineum helps to complete the pelvic walls, and stretches across between the descending rami of the pubic bones. It occupies a horizontal position, and has superior aud inferior surfaces. Posteriorly it fuses with the deep fascia of the perineum.

The *Obturator Membrane* fills the obturator foramen, leaving superiorly a small canal, through which vessels and nerves pass.

There are no muscles acting on these joints in the ordinary way, the joints being for the sole purpose of preventing absolute rigidity, so that the pelvis will "give" to the pull of the muscles as required.

The **Hip-Joint** takes place between the head of the femur and the acetabulum of the innominate bone.

It is a true ball-and-socket joint, so has movement round three axes:

Transverse—flexion and extension.

Antero-posterior—abduction and adduction.

Vertical—rotation in and out.

Ligaments.—The *Transverse Ligament* is composed of strong fibres, which bridge across the notch in the margin of the acetabulum, leaving a gap through which vessels and nerves can pass.

The *Cotyloid Ligament* surrounds the margin of the acetabulum and deepens the socket. Its free edge is somewhat constricted, and grasps the head of the femur.

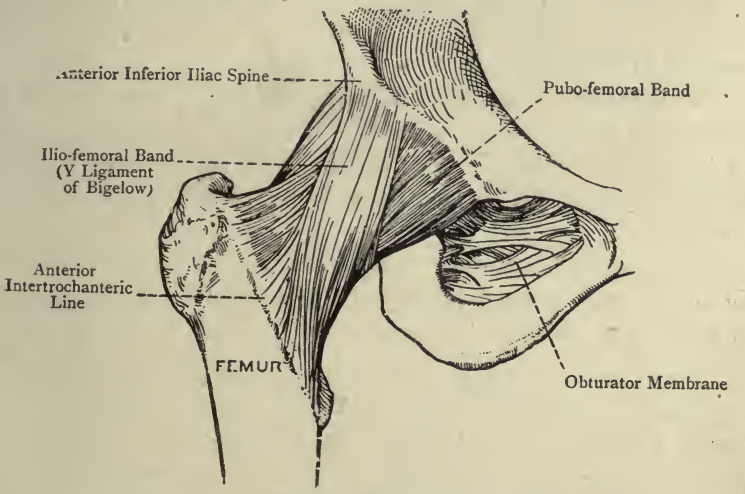


FIG. 18.—HIP-JOINT.

A *capsule* completely surrounds the joint. It is considerably thicker superiorly. This capsule differs from that of the shoulder-joint in not allowing the ball to be drawn from the socket to any considerable extent. The ligament is attached above to the margin of the acetabulum and below to the cotyloid and transverse ligaments. On the neck of the femur it is attached above to the root of the great trochanter, in front to the intertrochanteric line, below to the root of the small trochanter, and behind a little way above the intertrochanteric ridge. The fibres of the capsule are arranged in both the circular and longitudinal directions to give additional strength,

and definite bands of longitudinal fibres are strengthened as follows:

The *Ilio-Femoral* ligament (**Y**-shaped ligament of Bigelow) is a triangular ligament attached by its apex to the root of the anterior inferior spine and margin of the acetabulum and by its base to the intertrochanteric line. At the base the sides are thicker than the centre, hence its name.

The *Pubo-Femoral* ligament, attached to the acetabular end of the ramus of the pubis and the inferior aspect of the neck of the femur.

The *Ischio-Capsular* ligament attached above to the ischium just in front of the small sciatic notch; the lower end becomes merged in the capsule.

The *Ligamentum teres* is a flattened band of tissue attached by one end to the fossa on the summit of the head of the femur and by the other end to the sides of the notch in the margin of the acetabulum. A pad of fat occupies the bottom of the acetabulum.

The *synovial membrane* completely lines the joint and the ligaments, and hangs in loose folds between the articular margin and the attachment of the capsule on the neck of the femur.

MUSCLES ACTING ON THE JOINT.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Iliacus	From a wide origin round the margin of the iliac fossa	Outer side of tendon of psoas; anterior surface of small trochanter, and shaft of femur below	Anterior crural
	Psoas	From the intervertebral discs, and adjacent margins, side of bodies, and transverse processes of lumbar vertebræ	Apex of small trochanter of femur	Nerve from the lumbar plexus
	Sartorius	From the anterior superior spine of the ilium, and half the notch below it	Inner surface of shaft of tibia just below the tuberosity	Anterior crural
	Rectus femoris	See Quadriceps Extensor	(Knee-Joint)	

MUSCLES ACTING ON THE JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion (*contd.*)	Pectineus	From the triangular surface of the pubic bone behind the crest	Into the upper half (about 2 inches) of the line from the small trochanter to the linea aspera	Anterior crural
	Gracilis	From the edge of the symphysis pubis and a small portion of the border of the adjoining pubic arch	Into the inner side of the tibia, just below the tuberosity behind sartorius	Obturator
Extension	Gluteus maximus	From the area on the posterior part of the dorsum ilii between the crest and the superior curved line; the tendon of erector spinæ; posterior surface of sacrum, and great sciatic ligament	The gluteal ridge (from the root of the great trochanter) and the deep fascia covering the thigh	Inferior gluteal
	Gluteus medius	From the area on the dorsum ilii between the superior curved line and crest above and the middle curved line below; and deep fascia	Into the oblique line on the outer surface of the great trochanter	Superior gluteal
	Gluteus minimus	From the area on the dorsum ilii between the middle and inferior curved lines	The anterior surface of the great trochanter	Superior gluteal
	Biceps femoris	From the lower and inner half of the ischial tuberosity; and short head, from the whole length of the outer lip of the linea aspera, and the upper two-thirds of the outer supra-condyloid ridge and intermuscular septum	The head of the fibula, and by a slip to the outer tuberosity of the tibia	Great sciatic
	Semitendinosus	From the lower inner facet on the ischial tuberosity with the long head of biceps	The inner side of shaft of tibia, below the gracilis and behind sartorius	Great sciatic
	Semimembranosus	From the upper outer facet on the ischial tuberosity	The horizontal groove on the posterior surface of the inner tuberosity of the tibia	Great sciatic

MUSCLES ACTING ON THE JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Extension (*contd.*)	Adductor magnus	From a curved origin on the inferior surface of the ischial tuberosity, and the lower border of the ischial ramus and that of the pubis	The space below the insertion of quadratus femoris, the whole of the linea aspera, the inner supracondyloid ridge and intermuscular septum of the femur, and the adductor tubercle	Obturator
Abduction	Tensor fascia femoris	From the anterior superior spine of the ilium and the crest just behind	The ilio-tibial band at the level of the great trochanter	Superior gluteal
	Gluteus medius (anterior fibres)	See Extension		
	Gluteus minimus (anterior fibres)	See Extension		
Adduction	Adductor longus	By a rounded tendon from the anterior surface of the body of the pubis between the crest and the symphysis	The middle half of the inner lip of the linea aspera in front of adductor magnus	Obturator
	Adductor brevis	From the front of the body and descending ramus of the pubis	Into the lower two-thirds of the line leading from the small trochanter to the linea aspera behind pectineus	Obturator
	Adductor magnus	See Extension		
	Gracilis	See Flexion		
	Pectineus	See Flexion		
Rotation in	Gluteus medius (anterior fibres)	See Abduction		
	Gluteus minimus (anterior fibres)	See Abduction		

MUSCLES ACTING ON THE JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Rotation in (*contd.*)	Tensor fasciæ femoris	See Abduction		
Rotation out	Pyriformis	From the middle part of the anterior surface of the sacrum; and the upper margin of the great sciatic notch	A facet on the inner aspect of the upper border of the great trochanter	Nerve from the sacral plexus
	Obturator internus and gemelli	From the inner surface of the bone surrounding the obturator foramen and from the membrane; the gemelli, one from the ischial spine, the other from the tuberosity (either side of the small sciatic notch)	Just behind pyriformis	Nerve from the sacral plexus
	Obturator externus	From the lower half of the obturator membrane and the bone surrounding	The digital fossa at the inner aspect of the upper border of the great trochanter	Obturator
	Quadratus femoris	From the outer margin of the ischial tuberosity	The quadrate tubercle and line beyond	Nerve from the sacral plexus
	This act	ion is helped by a great	many of the other muscles.	
	Circumd	uction—a combination	of the other movements.	

The **Knee-Joint** is formed between the condyles of the femur and the superior surface of the head of the tibia. The posterior surface of the patella also enters into the joint.

A hinge-joint capable of movement round one axis only:

Transverse—flexion and extension.

A *capsule* surrounds the joint. It is, however, incomplete in front where the tendon of the quadriceps extensor takes its place. It has, as usual, distinct bands of fibres forming strengthening fibres; but they are not sufficient, so that expansions from the tendons of adjacent muscles are also found.

The *Anterior Ligament* (ligamentum patellæ) is a strong flat band, the tendon of the quadriceps extensor, attached to the apex and margins of the patella, and continued on to be inserted

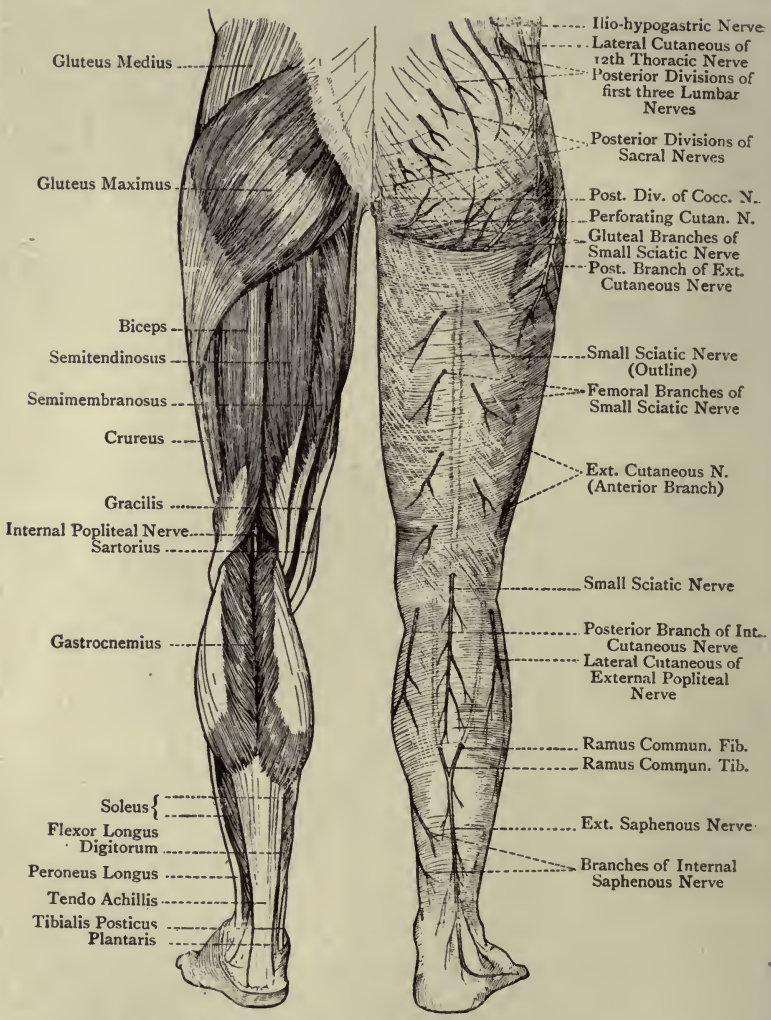


FIG. 19.—MUSCLES AND CUTANEOUS NERVES OF LEG (POSTERIOR VIEW).

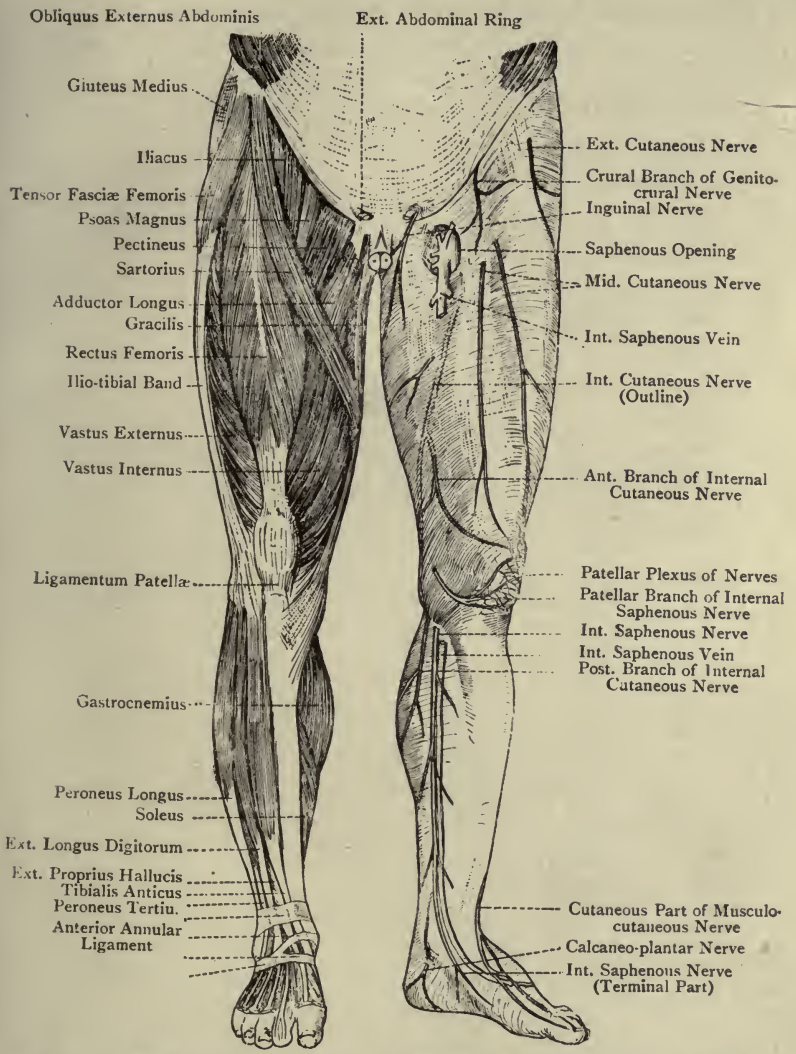


FIG. 20.—MUSCLES AND CUTANEOUS NERVES OF LEG (ANTERIOR VIEW).

into the anterior tubercle of the tibia. Expansions of the vasti tendons, called lateral patellar ligaments, augment this.

The *Posterior* ligament is attached superiorly to the popliteal surface of the femur just above the intercondyloid notch and the two condyles; below to the posterior border of the head of the tibia; on the fibular side, is an opening for the tendon of

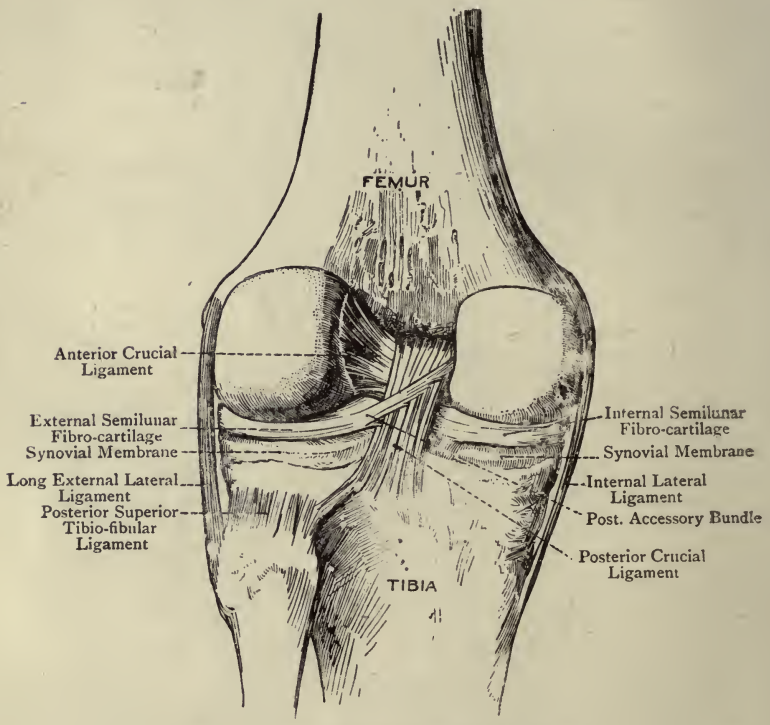


FIG. 21.—KNEE-JOINT (POSTERIOR VIEW).

popliteus. The tendon of semimembranosus forms an expansion to strengthen the ligament, called the oblique popliteal ligament.

The *Internal Lateral* ligament is a strong, flat band, rather wider in the middle. It is attached above to the inner surface of the internal condyle just below the adductor tubercle, and below to the inner surface of the internal tuberosity of the tibia,

reaching round to the part above the groove for semimembranosus.

The *External Lateral* ligament is a rounded ligament attached above to a tubercle on the outer surface of the external condyle and below to the head of the fibula in front of the styloid process; at its attachment it splits the tendon of biceps. This ligament is inside the capsule and not part of it.

The Intra-Articular Ligaments.—The ligaments *inside* the knee-joint are more important than the intra-articular ligaments of any other joint.

The *Crucial* ligaments are two rounded tendinous bands attached to the head of the tibia and the non-articular surfaces of the condyles of the femur; they are called anterior and posterior, according to their tibial attachment. The *Anterior Crucial* ligament is attached to the head of the tibia just in front of the spine, and passes upwards and backwards, to be attached to the posterior part of the inner surface of the external condyle. This ligament is tense during extension. The *Posterior Crucial* ligament is attached to the head of the tibia behind the spine, and passes upwards and forwards, to be attached to the anterior part of the outer surface of the internal condyle. This ligament is tense during flexion.

The *Semilunar Cartilages* are placed between the articulating surfaces of the tibia and femur; they each have a thick convex outer border attached to the surface of the tibia, and a concave inner border ending in horns, anterior and posterior. The *internal* one forms nearly a semicircle. The anterior horn is attached just in front of the anterior crucial ligament, and the posterior horn just in front of the posterior crucial ligament between it and the spine. The *external* one is nearly circular, its two horns being attached one each side of the spine.

The *transverse* ligament is a rounded band stretched between the anterior margins of the two semilunar cartilages.

The *synovial membrane* is very large and complicated. It completely invests the capsule, all the interarticular ligaments, and a pad of fat which is found beneath the patella, where it forms a fold attached to the patella and the anterior part of the intercondyloid notch. This is called the plica

synovialis patellaris. In addition it forms at the patellar end wing-like expansions—the plica alares—which are usually loaded with fat.

MUSCLES ACTING ON THE JOINT.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Hamstrings, consisting of—			
	Biceps	See Hip-Joint		
	Semi-membranosus			
	Semitendinosus			
	Sartorius			
	Gracilis			
	Gastrocnemius	By two heads—(1) On the upper part of the external condyle and supracondyloid ridge; (2) from the space between the internal condyle and the adductor tubercle	The tendo Achillis inserted in the middle part of the posterior surface of the os calcis	Tibial
	Plantaris	From the lower third of the outer supracondyloid ridge	The tendo Achillis, or a separate insertion on its inner side	Tibial
	Popliteus	By a tendon from the outer surface of the external condyle	The triangular surface on the upper part of the posterior surface of the tibia above the oblique line	Tibial
Extension	Quadriceps extensor, consisting of four parts			
	Rectus femoris	The straight head from the anterior inferior spine of the ilium and the reflected head from a groove just above the acetabulum	The upper border of the patella and the ligamentum patellæ	Anterior crural
	Vastus externus	From the anterior surface of the shaft of the femur in front of the great trochanter round to the outer lip of the linea aspera and its upper half; deep fascia	The upper and outer border of the patella and the ligamentum patellæ	Anterior crural

MUSCLES ACTING ON THE JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Extension	Vastus internus	From the lower two-thirds of the intertrochanteric line, the inner lip of the linea aspera, and upper two-thirds of the line from the linea aspera to the inner condyle; deep fascia	The upper and inner border of the patella and the ligamentum patellæ	Anterior crural
	Crureus (vastus intermedius)	From the anterior and outer surfaces of the upper two-thirds of the shaft of the femur; the lower half of the outer lip of the linea aspera and the line leading to the outer condyle; deep fascia	The deep surface of the tendons of rectus femoris and the vasti, and the ligamentum patellæ	Anterior crural

The **Tibio-Fibular Joints** are two in number, between the opposing surfaces of the extremities of the tibia and fibula. The fibula forms a lateral support for the ankle-joint, and is not required to have any independent movement, so these joints simply provide a certain amount of elasticity, and are slightly gliding.

The **Superior Tibio-Fibular Joint** is formed between the small oval facet on the inner surface on the head of the fibula, and the facet on the posterior part of the external tuberosity of the tibia. It is surrounded by a capsule and several strengthening ligaments, more or less defined.

The *synovial membrane* is sometimes continuous with that of the knee-joint.

The **Inferior Tibio-Fibular Joint** is formed between the opposing surfaces of the lower ends of the tibia and fibula; this is not always a separate joint, but may be only a series of ligaments accessory to the ankle-joint. The ligaments are particularly strong.

The *Anterior Inferior Tibio-Fibular* ligament is a strong band

of fibres attached to the front of the lower end of the tibia and the outer malleolus.

The *Posterior Inferior Tibio-Fibular* ligament is also a strong band of fibres attached similarly on the posterior aspect of the bones.

The *Transverse Inferior Tibio-Fibular* ligament is attached to the posterior inferior border of the tibia, and the pit or fossa on the posterior part of the inner surface of the external malleolus.

The *Interosseous* ligament connects the opposing surfaces; it is continuous above with the interosseous membrane, and attached in front and behind to the ligaments.

The *synovial membrane* lining the joint cavity is continuous with that of the ankle-joint.

The *Interosseous membrane* attached to the interosseous borders may be considered an accessory ligament to these joints. It joins the inferior tibio-fibular joint below and may join the superior tibio-fibular joint above, but there is always an opening in its upper part for the anterior tibial vessels. Its fibres are mainly directed downwards and outwards.

The **Ankle-Joint**, between the upper, inner, and outer surfaces of the astragalus and the lower ends of the tibia and fibula.

It is a hinge joint, capable of movement round one axis only:

Transverse—flexion and extension.

Owing to the shape of the articular surface of the astragalus, which is wider in front than behind, a slight side to side rocking movement can be produced during extension, as in this position the narrower portion of the astragalus is in the tibio-fibular socket. During flexion the wider part of the astragalus is forced into the socket, and the joint is, so to speak, "locked," and inversion and eversion of the foot can only be performed by outside force. This movement takes place in the joint between the cuboid and os calcis, and between the astragalus and scaphoid, not at all in the ankle-joint itself.

A *capsule* completely surrounds the joint, and has various strengthened parts.

The *Anterior* ligament is a thin ligament attached above to the anterior edge of the tibia, and below to the upper border of the head of the astragalus. A pad of fat fills the hollow between.

The *Posterior* ligament is attached to the edges of the tibia and astragalus, and receives some fibres from the external malleolus. The transverse ligament of the inferior tibio-fibular joint strengthens this aspect of the ankle-joint. The ligament on the external aspect of the joint is divided into three parts :

1. *Anterior Part* of the ligament from the anterior border of the external malleolus to the astragalus in front of the articular surface.

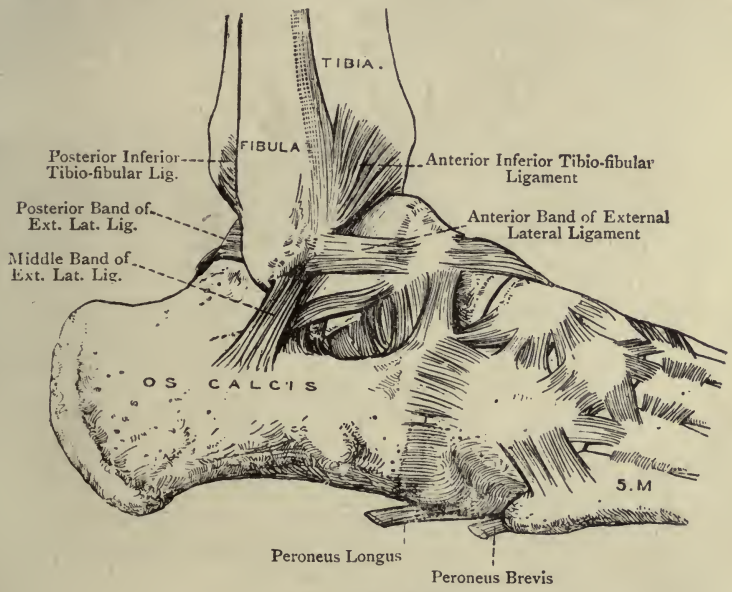


FIG. 22.—ANKLE-JOINT.

2. *Middle Part* of the ligament from the lower border of the external malleolus to the external surface of the os calcis just above the peroneal spine ; this is a strong rounded cord.

3. *Posterior Part* of the ligament from the fossa on the inner surface of the external malleolus to the external tubercle on the posterior surface of the astragalus ; this is the strongest of the three parts.

The *Deltoid* ligament is the one on the inner aspect of the joint ; it is triangular in shape and attached by its apex to the

lower part of the internal malleolus, and by its base to the inner surfaces of the scaphoid, astragalus, and os calcis, in one continuous line.

The *synovial membrane* lines the joint and is continued up into the inferior tibio-fibular joint. Pads of fat are found in front and behind the joint, and in the socket where the three bones meet.

The **Intertarsal Joints** are all gliding joints. They are surrounded by capsules which are divided into definite bands of fibres, as in the intercarpal joints. There are, however, three ligaments of special importance, as they are mainly responsible for supporting the longitudinal arch of the foot.

The *Inferior Calcaneo-Navicular or Spring* ligament is an extremely strong band of fibro-cartilage. It is attached by one end to the sustentaculum tali of the os calcis, and by the other to the plantar surface of the scaphoid. Some of its fibres radiate upwards to join the deltoid ligament.

The *Inferior Calcaneo-Cuboid* ligaments are two in number; the *superficial or long plantar* ligament is attached by one end to the plantar surface of the os calcis in front of the tuberosities, and by the other to the ridge of the cuboid and passing over the groove to the bases of the third, fourth and fifth metatarsals.

The *deep or short plantar* ligament is attached to the front of the plantar surface of the os calcis, and to the plantar surface of the cuboid just behind the ridge; this is a short band of great strength.

The tarso-metatarsal joints, intermetatarsal joints, metatarso-phalangeal joints, and interphalangeal joints all resemble the corresponding joints in the hand; but the movement is very limited, as the foot is for the purpose of supporting the weight of the body, and strength rather than flexibility has to be considered. The toes can be spread to a certain extent, constituting abduction and adduction at the metatarso-phalangeal joints. This movement takes place about a line drawn through the second toe, not the middle one. Inversion—the movement of raising the inner border of the foot—and eversion—raising the outer border of the foot—has already been described. This can

be done by outside force when the ankle is flexed, or voluntarily when the foot is on the ground.

The Arches of the Foot.—The foot having to support the whole weight of the body, that weight is distributed among its component parts by the arrangement of two arches at right angles to one another—longitudinal and transverse.

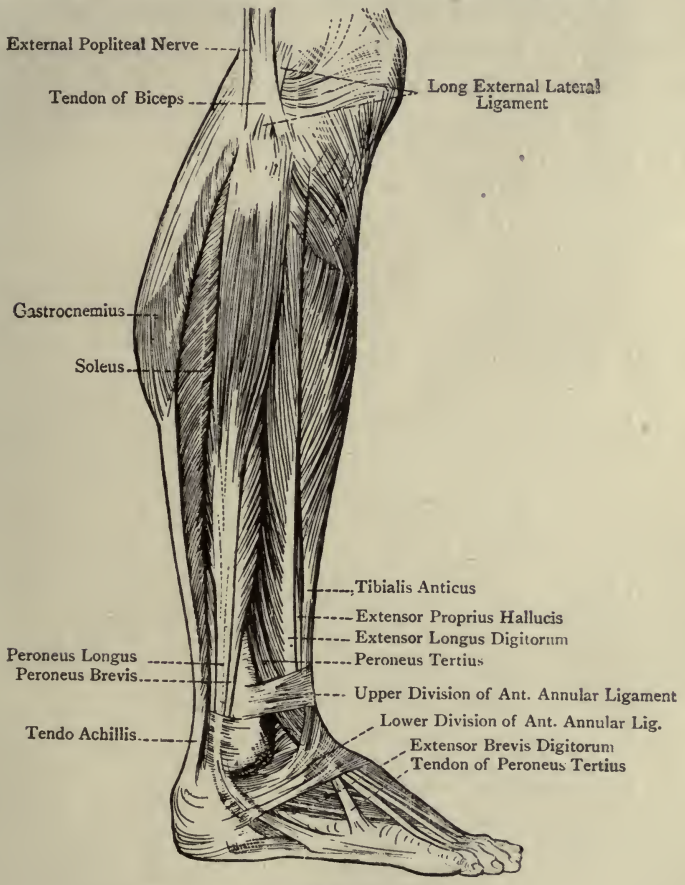


FIG. 23.—MUSCLES OF LEG.

The *Longitudinal Arch* consists of a solid stable pier posteriorly—the os calcis; and an elastic resilient pier anteriorly, which is much broadened out and consists of several parts, so that stability is not sacrificed to resilience. The summit, or roof,

of the arch is the astragalus. The bones of the foot are really arranged in two longitudinal columns. The inner one consists of the os calcis, scaphoid, three cuneiforms, and first, second, and third metatarsals; the outer one consists of the os calcis, cuboid, and fourth and fifth metatarsals. In this way the weight is evenly distributed to the front of the foot, which is necessary in the upright position, as the line of gravity falls in front of the knee-joint. The arch is kept in shape by the plantar ligaments, plantar fascia, and tendon of tibalis posticus which act as ties.

The *Transverse Arch* is most marked at the tarso-metatarsal joints. The outer border of the foot is lower than the inner, so that when the two feet are placed side by side the transverse arch is complete.

MUSCLES ACTING ON THE ANKLE-JOINT.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Tibialis anticus	From the external tuberosity and upper two-thirds of the outer surface of the shaft of the tibia: the interosseous membrane and deep fascia	The anterior part of the inner surface of the first cuneiform and base of the first metatarsal	Anterior tibial
	Extensor communis digitorum	From the outer tuberosity of the tibia and the upper two thirds of the anterior surface of the shaft of the fibula and deep fascia	The muscle divides into four tendons, and is inserted into the four outer toes in the same manner as the extensors of the fingers	Anterior tibial
	Extensor proprius hallucis	From the anterior surface of the shaft of the fibula in its middle three fifths; internal to that of extensor communis digitorum and the interosseous membrane	The base of the terminal phalanx of the great toe (hallux)	Anterior tibial
	Peroneus tertius	Is really part of extensor communis digitorum, and arises from the lower part of the anterior surface of the fibula and interosseous membrane	The dorsal surface of the base of the fifth metatarsal	Anterior tibial

MUSCLES ACTING ON THE ANKLE-JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Extension	Gastrocnemius Plantaris Soleus	These constitute the gro and extend the ankle the foot is on the gro movement from true	up called calf muscles, by raising the heel when und—a slightly different extension of the ankle	
	Gastrocnemius	See Knee-Joint		
	Plantaris	See Knee-Joint		
	Soleus	(1) From the posterior surface of the head and upper two-thirds of the shaft of the fibula; (2) from a fibrous arch between the tibia and fibula; (3) from the oblique line and middle third of the inner border of the tibia	Tendo Achillis	Tibial
	Tibialis posticus	From the upper three-fourths of the shaft of the fibula between the oblique line and the interosseous border; the external tuberosity of the tibia and the inner half of the upper two-thirds of the shaft below the oblique line; the interosseous membrane and deep fascia	The plantar surfaces of all the bones of the foot except the first metatarsal. As the tendon passes round the internal malleolus a slip is inserted into the sustentaculum tali	Posterior tibial
	Flexor longus digitorum	From the middle half of the posterior surface of the shaft of the tibia internal to that of tibialis posticus and deep fascia	The muscle divides into four tendons, which are inserted into the bases of the terminal phalanges of the four outer toes (*cf.* flexor profundus digitorum)	Posterior tibial
	Flexor longus hallucis	From the lower two-thirds of the posterior surface of the shaft of the fibula and the deep fascia	The base of the terminal phalanx of the great toe	Posterior tibial
Inversion and Adduction	Tibialis anticus	See Flexion		
	Tibialis posticus	See Extension		

MUSCLES ACTING ON THE ANKLE-JOINT—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Eversion and Abduction	Peroneus longus	From the head and upper two-thirds of the outer surface of the shaft of the fibula	The tendon passes through the groove in the cuboid, and is inserted on the outer surface of the first cuneiform and the base of the first metatarsal	Musculo-cutaneous
	Peroneus brevis	From the lower two-thirds of the outer surface of the shaft of the fibula	The tubercle and outer surface of the base of the fifth metatarsal	Musculo-cutaneous

MUSCLES ACTING ON THE METATARSO-PHALANGEAL JOINTS.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Flexor longus digitorum	See Ankle-Joint		
	Accessorius	The outer head from the outer border of the plantar surface of the os calcis and the long plantar ligament; the inner head from the inner surface of the os calcis and long plantar ligament	The upper aspect of the tendons of flexor longus digitorum for second, third, and fourth toes	External plantar
	Lumbricales	The first from the tibial side of the innermost tendon of the flexor longus digitorum; the others from the adjacent sides of the three outer tendons	The dorsal expansions of the extensor tendons, etc., similar to the lumbricales in the hand	First lumbricales from internal plantar; the others from external plantar
	Flexor longus hallucis	See Ankle-Joint		
	Flexor brevis hallucis	From the inner part of the plantar surface of the cuboid and the tendon of tibialis posticus	The tendon divides to allow that of flexor longus hallucis to pass, and is inserted into the sides of the base of the first phalanx of the great toe	Internal plantar

MUSCLES ACTING ON THE METATARSO-PHALANGEAL JOINTS—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion (*contd.*)	Flexor brevis digitorum	From the greater tubercle on the plantar surface of the os calcis; from the plantar fascia and the deep fascia	The second phalanges of the four outer toes (*cf.* insertion of flexor sublimis digitorum in the hand)	Internal plantar
	Flexor brevis minimi digiti	From the base of the fifth metatarsal bone	The outer side of the base of the first phalanx of the little toe	External plantar
	Interossei	See Abduction and Adduction		
Extension	Extensor longus digitorum	See Ankle-Joint		
	Extensor brevis digitorum	From the upper surface of the os calcis in front of the articulation	The innermost tendon is inserted into the base of the first phalanx of the great toe, the others into the dorsal expansions of the next three toes	Anterior tibial
	Extensor proprius hallucis	See Ankle-Joint		
Adduction: *to the middle line of the second toe*				
	Adductor obliquus hallucis	From the plantar surface of the bases of the second, third, and fourth metatarsal bones	The outer side of the base of the first phalanx of the great toe	External plantar
	Adductor transversus hallucis	From the capsules of the outer four metatarso-phalangeal joints and the transverse metatarsal ligament	The outer side of the base of the first phalanx of the great toe	External plantar
	Plantar interossei	From the tibial sides of the third, fourth, and fifth metatarsal bones respectively	With the dorsal muscles on to the tibial sides of third, fourth, and fifth toes	External plantar
Abduction: *from the middle line of the second toe*				
	Abductor hallucis	From the inner side of the greater tuberosity on the plantar surface of the os calcis and the plantar ligament	The inner side of the base of the first phalanx of the great toe	Internal plantar

MUSCLES ACTING ON THE METATARSO-PHALANGEAL JOINTS—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Abduction (*contd.*)	Dorsal interossei	By two heads from the adjacent sides of the metatarsal bones	The first and second muscles are inserted on the tibial and fibular side of the second toe respectively; the two outer muscles are inserted on the fibular side of the third and fourth toes into the dorsal expansions	External plantar
	Abductor minimi digiti	From both tubercles on the plantar surface of the os calcis, the plantar fascia, and deep fascia	The outer side of the base of the first phalanx of the little toe	External plantar

MUSCLES ACTING ON THE INTERPHALANGEAL JOINTS.

Action.	Muscle.	Origin.
Flexion	Flexor brevis digitorum	See Metatarso-Phalangeal Joint
	Flexor longus digitorum	See Ankle-Joint
	Flexor longus hallucis	See ,,
Extension	Extensor longus digitorum	See ,,
	Extensor brevis digitorum	See Metatarso-Phalangeal Joint
	Interossei	See ,, ,,
	Lumbricales	See ,, ,,
	Extensor proprius hallucis	See Ankle-Joint

The short muscles of the toes in the sole of the foot are arranged in four layers beneath the plantar fascia. Starting at the outermost layer, they are—

First layer: Abductor hallucis, flexor brevis digitorum, abductor minimi digiti.

Second layer: Lumbricales and accessorius, and the tendons of the long flexor muscles.

Third layer: Flexor brevis hallucis, adductores hallucis, flexor brevis minimi digiti.

Fourth layer: Interossei (plantar and dorsal) and tendons of peroneus longus and tibialis posticus.

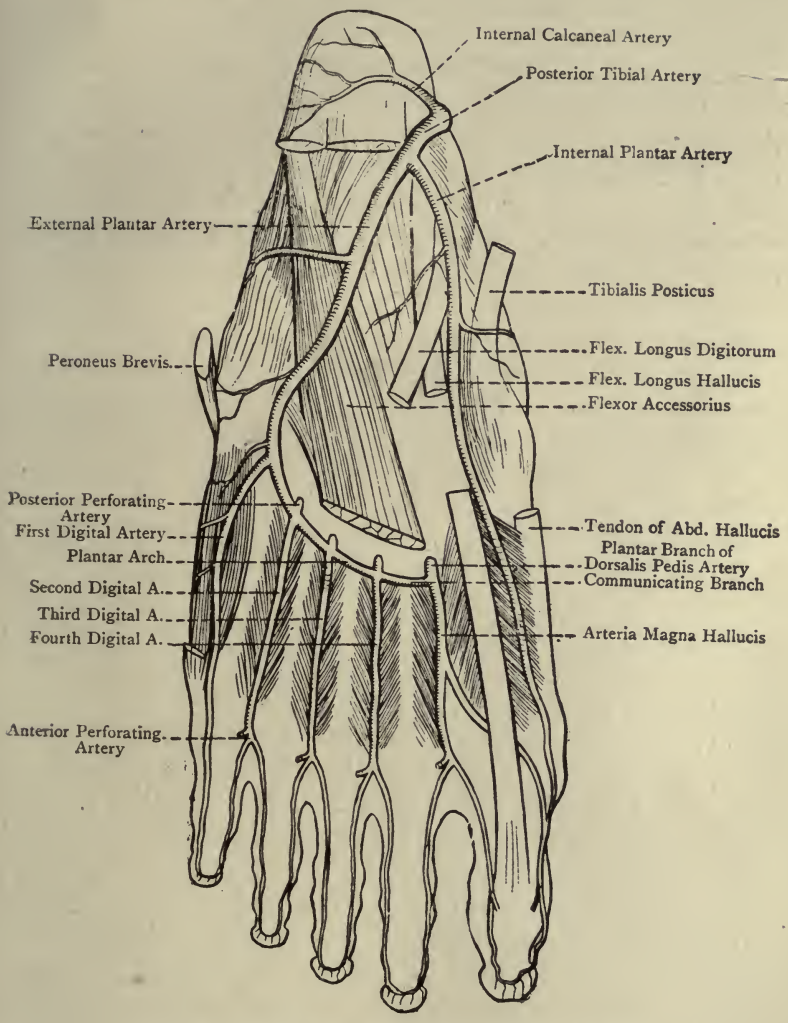


FIG. 24.—SHORT MUSCLES AND ARTERIES OF FOOT.

The **Deep Fascia** of the lower limb is continuous with that of the trunk, and that of the thigh is attached to the crest of the ilium, the pubic arch and symphysis, the great sciatic ligament, and Poupart's ligament; below it is attached to the patella, the tuberosities of the tibia, and the head of the fibula.

On the front of the thigh it is very thick, especially over the region of Scarpa's triangle, where there is an opening for the internal saphenous vein. On the outer surface of the thigh there is a strong band in the fascia, the *ilio-tibial* band, attached above to the iliac crest, and below to the outer tuberosity of the tibia. At the knee it forms the lateral ligaments of the patella attached to the patella and the tuberosities of the tibia. Just above the knee the deep fascia sends in expansions, intermuscular septa, which are attached to the supracondyloid ridges. On the back of the thigh the fascia is especially thick over the popliteal space, where it is pierced by the external saphenous vein.

Femoral Sheath. — A facial investment for the femoral vessels, formed by the deep fascia covering Scarpa's triangle above, and an expansion of the internal fascial lining of the abdominal wall which goes down deep to the vessels, so enclosing them between two layers of fascia. It is divided into three compartments—the outer one for the artery, the intermediate one for the vein, and the inner one for a lymphatic gland; this latter division is known as the crural canal.

The deep fascia of the leg is continuous with that of the thigh, and passing down the leg sends in septa between the muscles. At the ankle it is attached to the malleoli and the os calcis, and forms the annular ligament.

The *Internal Annular* ligament is attached to the internal malleolus and the tuberosity of the os calcis. A number of important structures pass beneath it—viz., tendon of tibialis posticus, tendon of flexor longus digitorum, post. tibial artery, post. tibial nerve, tendon of flexor longus hallucis.

The *External Annular* ligament is attached to the external malleolus and the os calcis, and the tendons of peroneus longus and brevis pass beneath it.

Across the front of the ankle there are usually three bands

of fascia, but occasionally more are found. The extensor tendons of the ankle pass beneath the uppermost one, and the anterior tibial vessels and nerve pass over it.

In the sole of the foot the fascia forms the very important *Plantar Fascia* attached to the tuberosity of the os calcis; anteriorly it spreads out and divides into five slips, which are attached to the digital sheaths of the toes. From the sides a thinner layer of fascia spreads out to cover the muscles and sends in intermuscular septa. The plantar fascia is instrumental in preserving the arch of the foot.

SECTION IV

VERTEBRÆ, RIBS, AND MUSCLES OF TRUNK

The vertebræ, thirty-three in number, articulating together, form the spinal column. They are named according to the region in which they are placed:

Cervical: 7—neck region.
Dorsal: 12—thoracic region.
Lumbar: 5—abdominal region.
Sacral: 5—pelvic region.
Coccygeal: 4—caudal region.

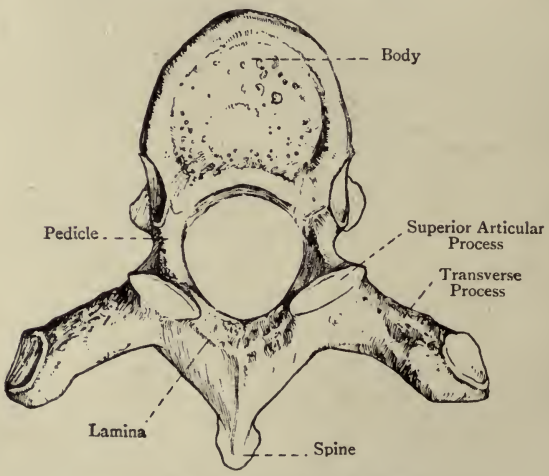


Fig. 25.— A Typical Vertebra.

The vertebræ are all constructed on the same plan, but differ slightly from one another in the various regions according to their necessities.

A typical vertebra consists of a body more or less cylindrical

in shape; the sides and upper and lower surfaces are slightly concave. Posteriorly, two short, stout processes—the pedicles—are formed; these support flattened laminæ, which fuse in the middle line; thus, the posterior surface of the body, the pedicles, and the laminæ form a bony canal through which the spinal cord runs. The pedicles are not as deep vertically as the bodies, so that between the pedicles of two adjacent vertebræ there are spaces left—the intervertebral foramina—through which the spinal nerves emerge. Immediately in front of the pedicles are other processes—the transverse, to which the muscles of the back are attached, and on the upper and lower surfaces of the pedicles are articular processes (four in all) for the articulation of the vertebræ one with another. At the junction of the laminæ a third process is developed, called the spine, for the attachment of muscles.

PRINCIPAL VARIATIONS IN VERTEBRÆ OF DIFFERENT REGIONS.

Vertebra.	Body.	Spine.	Transverse Process.
Cervical (first and second described separately)	Oval in shape	Short and bifid at the free end	Small, and with a foramen through which the vertebral artery runs
Dorsal	Heart-shape, with facets for heads of ribs	Long, thin, and pointing downwards	Have small facets for articulation with the tubercle of the rib
Lumbar	Kidney-shape	Short, stout, and horizontal	Point horizontally outwards, with several tubercles for attachment of muscles

The **Sacral** vertebræ are all fused together into one bone, called the sacrum.

The **Sacrum** is a triangular bone formed of the five sacral vertebræ, whose bodies and transverse processes have become fused together, distinct ridges being seen at the line of fusion on the anterior surface.

The anterior surface is concave from above downwards, and has four foramina on each side of the middle line for the passage of nerves. These are homologous with the intervertebral foramina, and, through the fusion of the transverse processes with one another, appear both anteriorly and pos-

teriorly. Above, the margin is projecting, forming the promontory of the sacrum. This is more marked in the male than the female.

The posterior surface is convex from above downwards, and

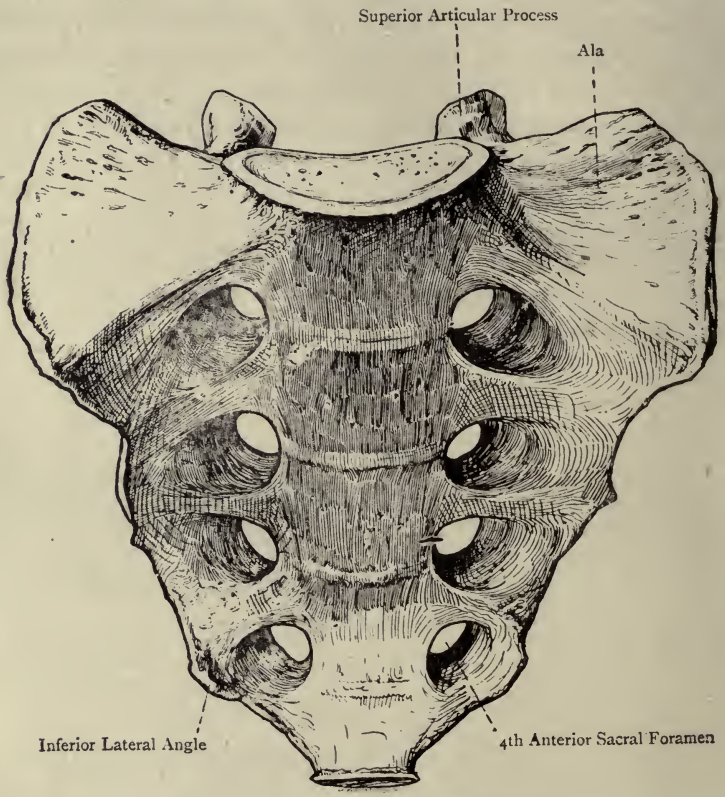


FIG. 26.—SACRUM (ANTERIOR SURFACE).

has the four foramina on each side, similar to the anterior surface. In the middle line the spines of the vertebræ still persist as four tubercles.

On each side of the upper part of the bone are the lateral masses, large stout masses of bone, on the external aspects of which are the surfaces for articulation with the innominate bone.

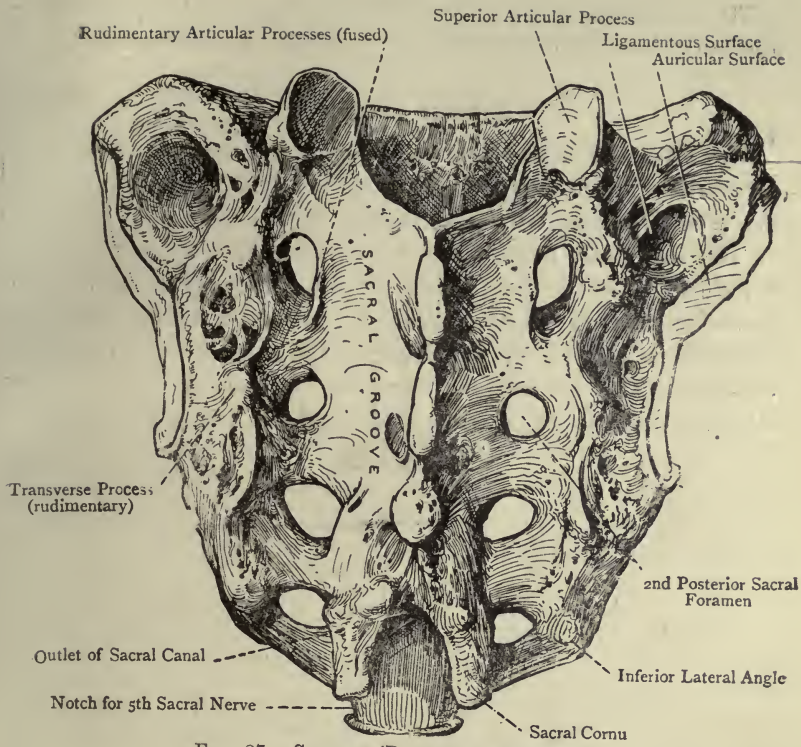


FIG. 27.—SACRUM (POSTERIOR SURFACE).

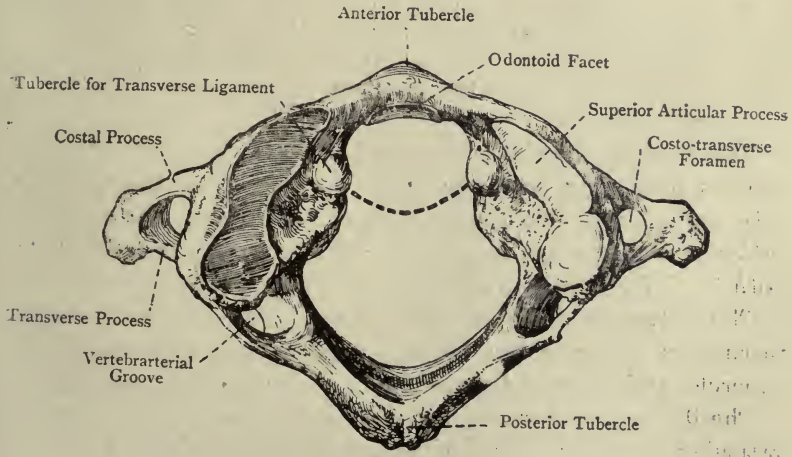


FIG. 28.—ATLAS.

The **Coccyx** consists of four rudimentary vertebræ, which are generally fused together, and often fused with the sacrum.

Special Vertebræ.

The **First Cervical** vertebra, or **Atlas,** differs from the typical vertebræ. It consists of a ring of bone supporting laterally, the lateral masses which articulate above with the condyles of the occipital bone, and below with the second cervical vertebra. Posteriorly, it has a rudimentary spine, and on the posterior surface of the anterior arch is a small facet for articulation with the odontoid peg of the axis, or second cervical vertebra. The transverse processes, similar to those of the other cervical vertebræ, are attached to the lateral masses.

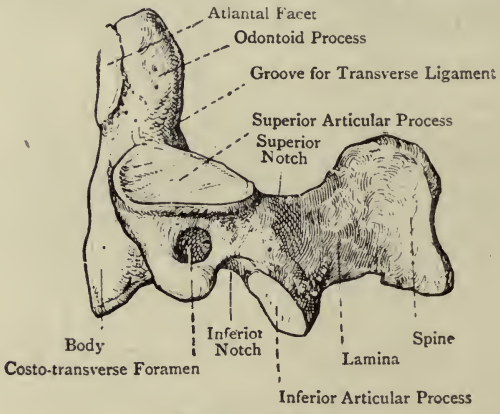


Fig. 29.—Axis.

The **Second Cervical** vertebra, or **Axis,** has the odontoid process projecting from the upper surface of its body, which articulates with the anterior arch of the atlas. The superior articular surfaces are large and nearly circular, to correspond with the inferior articular processes of the atlas.

The **Seventh Cervical** vertebra is called the vertebra prominens owing to the spine, which ends in a broad, single tubercle, and is markedly prominent at the root of the neck.

The **Dorsal,** or thoracic, vertebræ are characterized by having articular facets on their bodies for the heads of the ribs, and

on the transverse processes for the tubercles of the ribs. The facets on the bodies are usually placed midway on adjacent bodies, so that a demi-facet is found on the upper and lower margins of bodies.

The **Vertebral Column** as a whole. The vertebræ are so articulated that the bodies, transverse processes, and spinous processes are all superimposed. This causes posteriorly two longitudinal grooves, one each side of the spine, in which are placed the longitudinal muscles of the back.

Viewed from the side, it is seen that the column forms a series of curves, slightly forward in the cervical region, markedly backward in the thoracic region, and forward again in the lumbar region. The sacrum, again, is convex backwards, and the junction of the fifth lumbar vertebra with the sacrum is called the sacro-vertebral angle, which is always very marked.

Ossification.—Centres for the bodies and neural arches appear before birth. At puberty, epiphyses for the different processes and upper and lower surfaces of the bodies appear. All become completely fused about the twenty-fifth year.

The **Sternum,** or **Breast-Bone,** is in the middle of the upper part of the anterior wall of the thorax. It articulates on each side with the upper seven ribs and the clavicle. It consists of three parts—the manubrium or presternum, the body, and the ensiform or xiphoid cartilage.

The *Manubrium* is separate from the body, although occasionally it is found to be fused. It is a flattened, four-sided bone, the upper end being wider than the lower. At the superior angles it articulates with the first rib on each side, and immediately in front of this articulation on the upper margin are the facets for articulation with the clavicles, between which is the suprasternal notch. At its junction with the body is found the articulation for the second rib.

The *Body of the Sternum* is a long-shaped flat bone, with its sides notched for articulation with the second to the seventh ribs inclusive. At its upper end it articulates with the manubrium, and at the lower end is attached the ensiform cartilage, a pointed process which is partly ossified.

The *Sternum* lies obliquely downwards and forwards in the

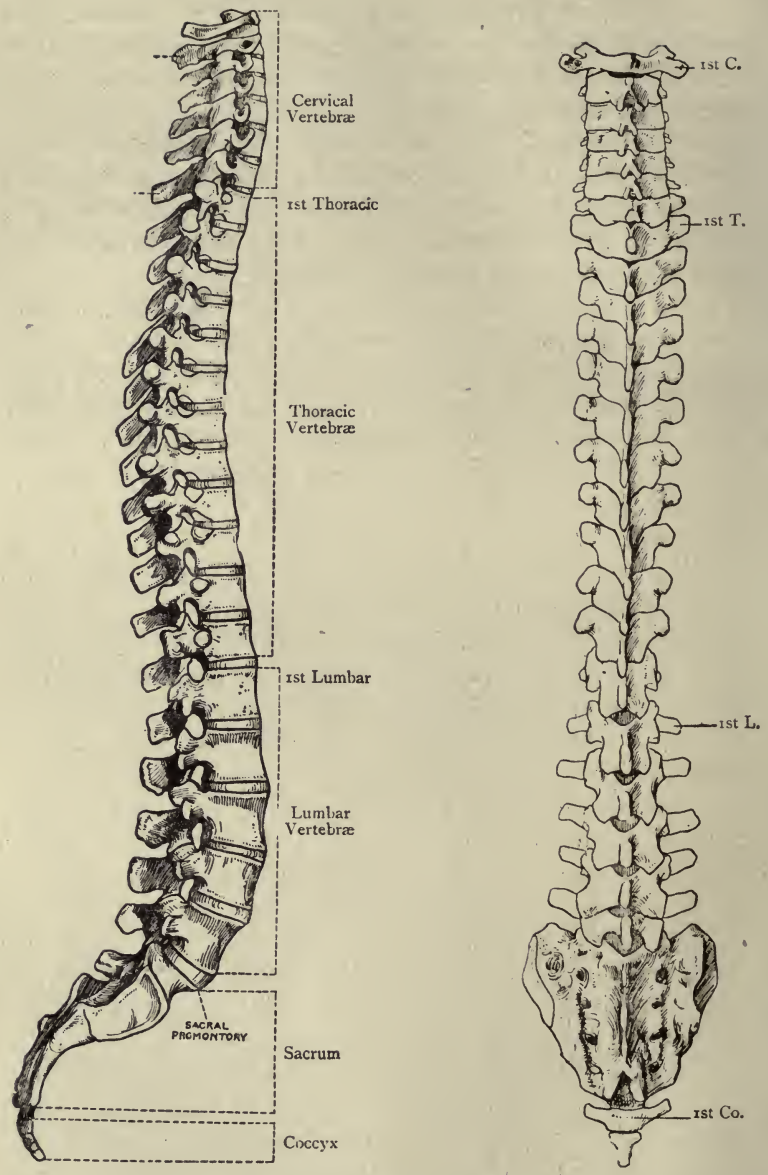


FIG. 30.—SPINAL COLUMN.

front of the chest. At rest its upper end is opposite the lower border of the second dorsal vertebra, and its lower end opposite that of the tenth.

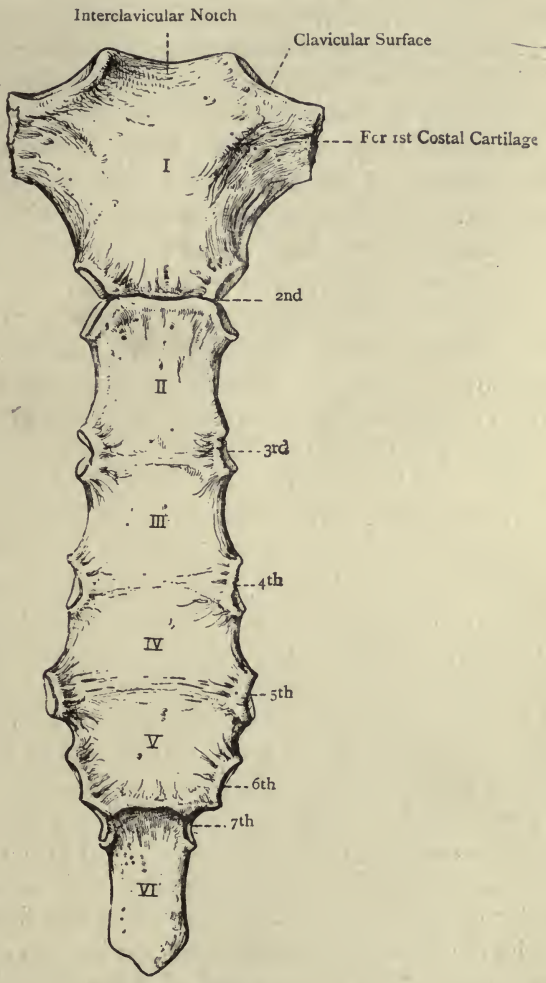


FIG. 31.—STERNUM.

Ossification.—Several centres are developed before birth, the whole becoming fused about the fortieth year.

The Ribs.

The **Ribs** (costæ) are twenty-four in number, twelve on each side. They articulate posteriorly with the dorsal vertebræ, and anteriorly with the sternum and one another (except the eleventh and twelth, which are free at their anterior ends), thus forming the lateral walls of the thorax.

A *rib* is a long, narrow, flat bone, consisting of a head and neck attached to the shaft. The head is somewhat expanded, and has on its inner surface a facet for articulation with the vertebræ, the lower half of which corresponds with the facet on the upper margin of the body of the vertebra corresponding with it, so that each rib articulates with the body of the vertebra with which it is in numerical sequence, and with the body of the one above. Thus, the seventh rib articulates with the upper margin of the body of the seventh vertebra and the lower margin of the body of the sixth. Below, the head is constricted to form a neck, and where it joins the shaft there is a tubercle on the posterior surface. The tubercle has a facet to articulate with the transverse process of the vertebra numerically corresponding with it. The shaft is long, flat, and narrow. It is convex laterally, but the curve is much sharper posteriorly than anteriorly, and where the curve is sharpest there is a rough, oblique ridge on the external surface; this is called the angle. On the first rib the tubercle and angle coincide. They gradually separate, being farthest apart on the eighth rib, and approaching one another again on the lower ones. The shaft of the rib is also twisted on itself, so that, if laid on a flat surface, one end is always raised up. This is most marked in the middle ones, and not found at all in the first, second, and twelfth. The upper border is thick and rounded, the lower one thin and sharp, and on the inner surface of the lower border is a groove for vessels and nerves. The anterior end of the shaft is slightly expanded and hollowed out for the attachment of the costal cartilage, by means of which the ribs articulate with the sternum or one another.

The *first rib* is much smaller than the others, quite flat, and forms nearly a semicircle. On its upper surface, about midway,

is a groove for the subclavian artery. On the inner border, about an inch from the anterior extremity, is the scalene tubercle. The surfaces are directed upwards and downwards.

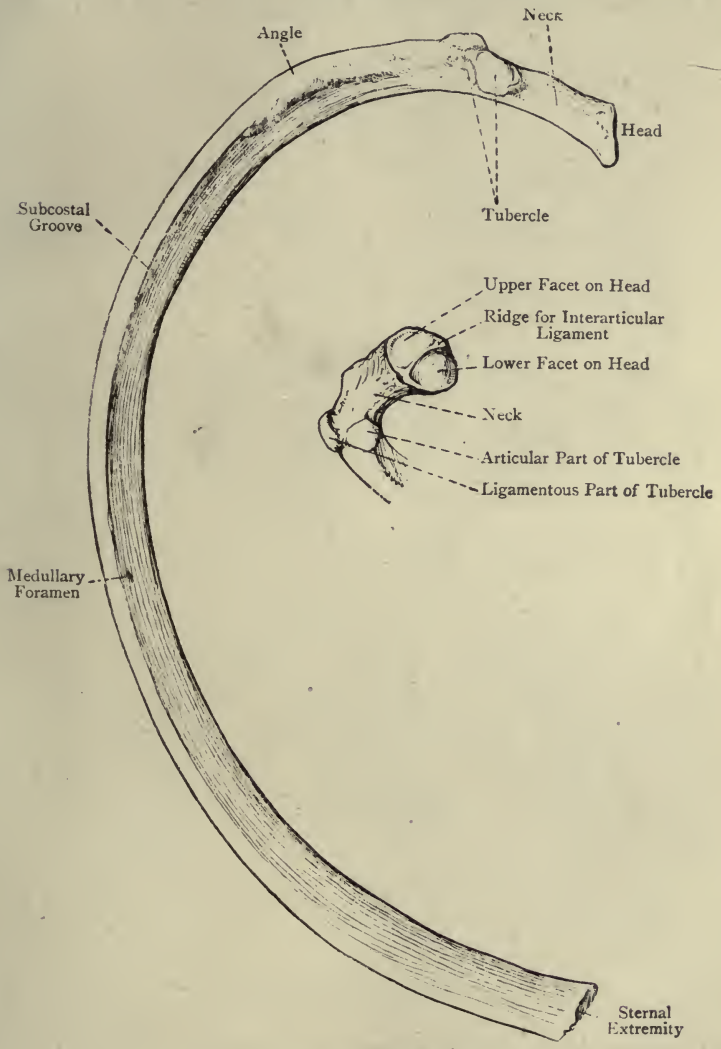


FIG. 32.—A TYPICAL RIB.

The *second rib* resembles the first in shape and in having no twist, but is a good deal larger. The surfaces are directed obliquely, similarly to those of the other ribs.

The *eleventh* and *twelfth* ribs are very much shorter and smaller than the others. Their anterior extremities are pointed and tipped with cartilage, but are free and non-articulating.

Ossification.—The shaft is almost completely ossified before

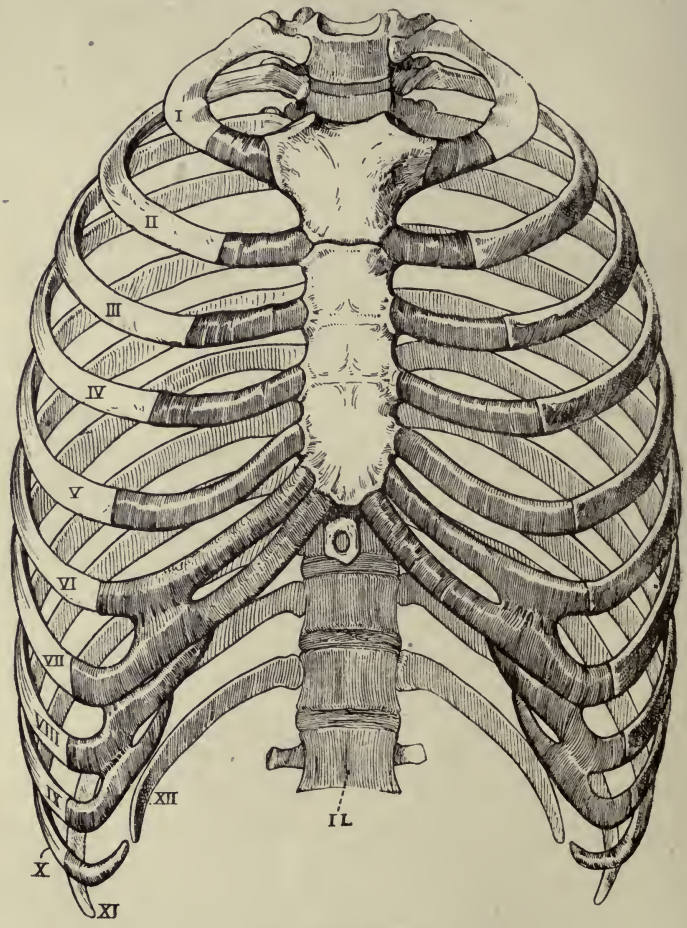


Fig. 33.—Thorax.

birth. Secondary centres for the head and tubercle appear before puberty, and the whole rib is fused by the twenty-fifth year.

The **Thorax** as a whole is barrel-shaped, narrower above than

below, and compressed antero-posteriorly. The inlet, or superior aperture, is kidney-shaped, its plane oblique, sloping downwards and forwards. The lower aperture is curved, and slopes upwards along the twelfth rib to the tip of the eleventh, along the cartilages of the tenth, ninth, eighth, and seventh ribs to the ensiform cartilage. This aperture is closed by the diaphragm.

Joints of the Vertebral Column.

The vertebræ articulate together by their bodies and the transverse processes. Each individual joint has not much power of movement, but, taken altogether, the range of movement of the spine as a whole is considerable.

Intercentral Articulations.—These take place between the flattened surfaces of the bodies of the vertebræ. Between the two surfaces is a cartilaginous disc, the *intervertebral disc.* In the cervical and lumbar region the disc is thicker in front than behind, and the reverse in the dorsal, thus helping to form the curves.

The *Anterior Longitudinal* ligament runs the whole length of the spinal column on the anterior surface, from the first cervical vertebra to the upper margin of the sacrum, and is firmly attached to the intervertebral discs as it passes over them.

The *Posterior Longitudinal* ligament resembles the foregoing, but is placed inside the spinal canal on the posterior surfaces of the bodies.

Interneural Articulations.—These take place between the articulating processes on the pedicles of adjacent vertebræ. These are gliding joints, each surrounded by a thin capsule lined by a synovial membrane. In addition, the ligamenta flava binds together the laminæ. This ligament is inside the spinal canal, and resembles the anterior and posterior longitudinal ligaments in being continuous throughout the length of the spinal column.

The spinous processes are attached to one another by interspinous ligaments. In continuity with them are the supraspinous ligaments, which extend all along the spinal column from tip to tip of the spines. In the cervical region these are

particularly developed, forming a partition between the muscles of the two sides, and called the ligamentum nuchæ.

The atlas and the axis have several additional ligaments joining them together, one being a transverse ligament, which is attached to the dorsal surface of the anterior arch of the axis, and passes behind the odontoid peg of the axis.

The spinal column as a whole is freely movable, and permits of movement round three axes—

Transverse—flexion and extension.
Antero-posterior—lateral flexion.
Vertical—rotation.

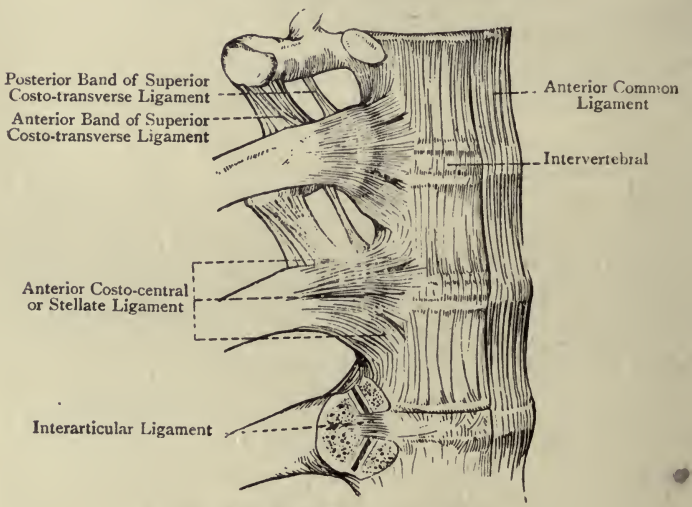


FIG. 34.—VERTEBRAL LIGAMENTS.

The articulations of the ribs, both with the vertebræ and the sternum, are by means of gliding joints, which allow the ribs to be raised and lowered by the muscles to perform the act of breathing.

Muscles of Trunk.

The actions of the muscles of the trunk are very complex. They are arranged in two main sets—

Muscles of the back.
Muscles of the abdominal wall.

The **Muscles of the Back** can again be divided into transverse and longitudinal. The transverse muscles are those which connect the shoulder girdle with the spinal column, and the longitudinal ones those that cause extension of the back and

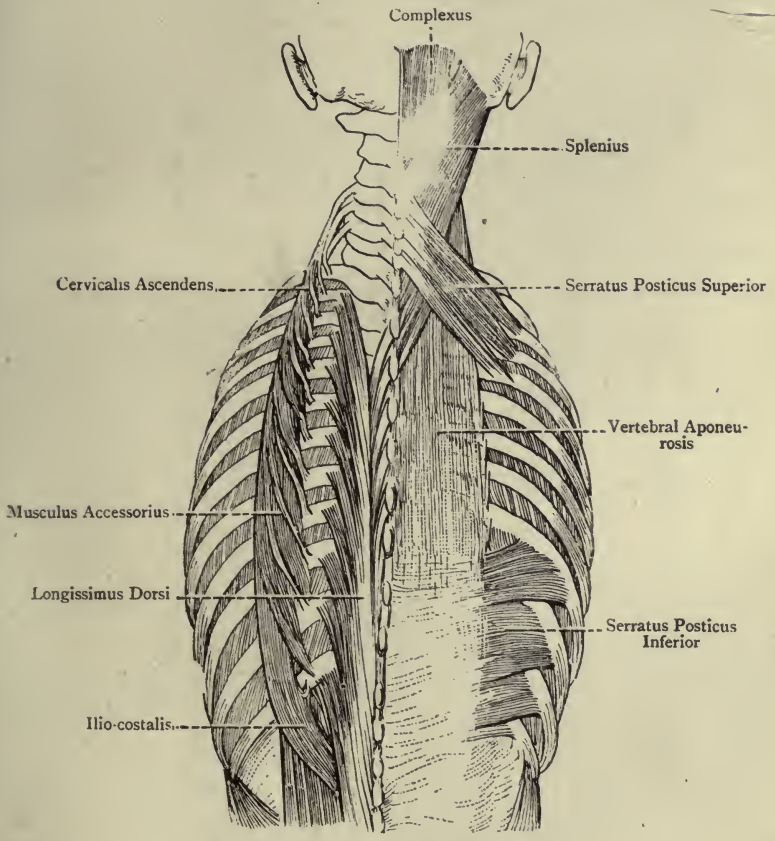


FIG. 35.—MUSCLES OF THE BACK.

the movements of the pelvis (as in locomotion), which correspond with those of the spinal column. The movements of the head on the spinal column will be considered in another section.

The muscles are arranged in four layers. Starting with the most superficial they are—

1. Trapezius and latissimus dorsi.
2. Levator anguli scapulæ and rhomboids.
3. Serrati postici superior and inferior, splenius capitis and splenius cervicis.
4. Erector spinæ and complexus.

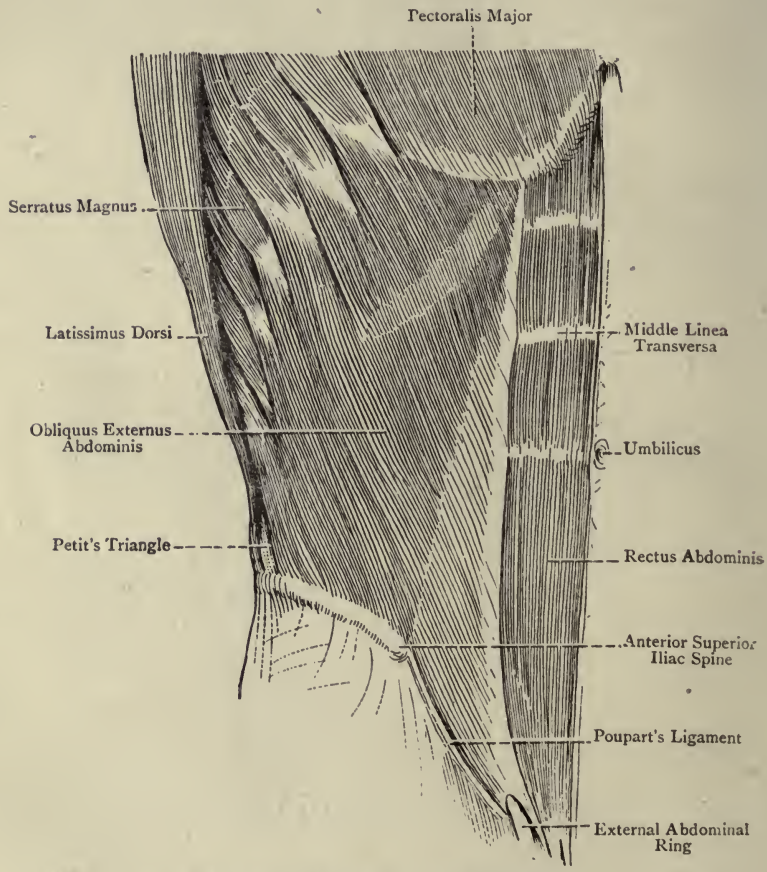


FIG. 36.—MUSCLES OF THE ABDOMEN.

Beneath these muscles are a large number of smaller ones that move the vertebræ on one another—*e.g.*, rotatores, interspinals, etc.

The **Muscles of the Abdomen** are arranged in three directions —longitudinal, transverse, and oblique. The longitudinal ones straight up the front, flex the trunk, helped by the oblique ones when both sides act together. When the oblique muscles act singly, rotation of the trunk takes place. The longitudinal muscles on the posterior wall of the abdomen extend the spine when both act together. Acting singly, they flex the spine laterally. The transverse muscles of the abdominal wall are mainly used to keep the contents of the abdomen in place and to add to the strength of the wall, but help in flexion with the others.

Some of the muscles causing flexion and extension of the cervical part of the spine are situated in the neck and attached to the head; these must not be confused with the muscles that specially move the head on the spine.

(For Flexion and Extension of Spinal Column, see pp. 94 and 95.)

The movement of lateral flexion of the spinal column takes place by the muscles of flexion and extension acting together on one side. In the cervical region, however, there are a group of muscles which cause lateral flexion of that part.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Lateral flexion	Scalenus anticus	From the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ	The scalene tubercle and ridge on the first rib	Anterior primary divisions of lower four or five cervical nerves
	Scalenus medius	From the transverse processes of the lower cervical vertebræ (second to sixth inclusive)	On the first rib behind the groove for the subclavian artery	Same as above
	Scalenus posticus	From the transverse processes of the fourth, fifth, and sixth cervical vertebræ	The outer surface of the second rib about the middle	Same as above

MUSCLES (BOTH SIDES TOGETHER) ACTING ON THE SPINAL COLUMN.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Longus colli	From the bodies and transverse processes of the first three thoracic and last three cervical vertebræ	The bodies and transverse processes of the upper cervical vertebræ	Anterior primary divisions of the upper cervical nerves
	Psoas	See Hip-Joint		
	Rectus abdominis	By two heads from the symphysis and crest of the pubis	The front of the ensiform cartilage and seventh, sixth, and fifth costal cartilages	Anterior primary divisions of the lower six thoracic nerves
	Obliquus externus abdominis (external oblique)	From the outer surfaces of the lower eight ribs interdigitating with serratus magnus and latissimus dorsi	The external lip of the iliac crest in its anterior half and into a broad aponeurosis covering the anterior abdominal wall. By this means it is attached to the pubic crest, and the lower free edge of the aponeurosis forms Poupart's ligament	Same as above
	Obliquus internus abdominis (internal oblique)	From the lumbar fascia, the anterior half of the iliac crest, and the outer half of Poupart's ligament	The outer surfaces of the last three ribs, and forming an aponeurosis into the seventh, eighth, and ninth costal cartilages and linea alba	Same as above
	Transversalis	From the inner surfaces of the lower six costal cartilages interdigitating with the diaphragm ; the lumbar fascia, anterior half of internal lip of iliac crest, and outer third of Poupart's ligament	The fibres form an aponeurosis, which joins with that of the other side to form the linea alba ; and below joins the lower part of the obliquus internus to form the conjoint tendon attached to the crest of the pubis	Same as above

MUSCLES (BOTH SIDES TOGETHER) ACTING ON THE SPINAL COLUMN—*Continued.*

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Extension	Complexus	From the transverse processes of the upper six thoracic and lower four cervical vertebræ	Between the superior and inferior curved lines of the occipital bone near the middle line	Posterior primary divisions of the spinal nerves
	Splenius capitis and cervicis	From lower half of ligamentum nuchæ and spines of seventh cervical and upper six dorsal vertebræ	Splenius capitis into the mastoid process and outer part of superior curved line of occipital bone; splenius cervicis into the transverse processes of the upper cervical vertebræ	Same as above
	Serratus posticus superior	From the ligamentum nuchæ and spines of seventh cervical and first four dorsal vertebræ	By slips into the second, third, and fourth ribs	Same as above
	Serratus posticus inferior	From the spines of the last two thoracic and first two lumbar vertebræ	By slips into the last four ribs	Same as above
	Erector spinæ	From the posterior half of the iliac crest, the posterior sacro-iliac ligament, the back of the sacrum, and spines of all the sacral and lumbar vertebræ	Divides into three portions: (1) Ilio-costalis, by slips into the lower six ribs; (2) the longissimus dorsi, by outer slips into all the ribs and inner slips into the transverse processes of the upper lumbar and all the dorsal vertebræ; (3) spinalis dorsi, into the spines of the upper dorsal vertebræ	Same as above
	Quadratus lumborum	Posterior part of iliac crest, ilio-lumbar ligament, and transverse processes of the lower lumbar vertebræ	Inner part of lower border of twelfth rib, and transverse processes of upper lumbar vertebræ	First three or four lumbar nerves

Poupart's ligament—the thickened free edge of the external oblique muscle from the anterior superior spine of the ilium to the spine of the pubis.

The movement of rotation of the spinal column can be defined as the approximation of the twelfth rib of the one side to the iliac crest of the other. It is carried out by the diagonal muscles of the trunk. Thus rotation to the left—*i.e.*, turning the body so that the right twelfth rib is brought nearer to the left iliac crest, is caused by the following muscles :

Right obliquus externus abdominis.
Left obliquus internus abdominis.
Left latissimus dorsi.
Left serratus posticus inferior.

Rotation to the right, by the opposite muscles acting together. This movement is made possible by the directions of the fibres of the muscles concerned, and the fact that the external oblique muscle of each side is inserted into the *whole* of the pubic crest, so that the right external oblique gets some of its fibres inserted into the left pubis, and *vice versa*, consequently is able to pull its own side of the trunk over to the other.

Muscles of the Thorax.

This group of muscles can equally well be called the muscles of respiration, as they are the ones that raise the ribs or otherwise enlarge the cavity of the thorax, and make respiration possible.

Muscle.	Origin.	Insertion.	Nerve-supply.
Diaphragm	From the ventral surface of the ensiform cartilage ; from the ventral surfaces of the cartilages of the lower six ribs interdigitating with transversalis ; by two crura from the fronts of the bodies of the upper lumbar vertebræ—three on the right side, two on the left—which decussate in front of the aorta ; and from the arcuate ligaments, which are thickenings in the fascia covering psoas and quadratus lumborum	It is inserted into a large trilobed central tendon, which is developed in the muscle itself, and has no bony attachment	Phrenic

Inspiration, caused by the elevation of the ribs and depression of the diaphragm.

The intercostal muscles fill up the spaces between the adjacent ribs. They are arranged in two sets, external and internal, eleven pairs of each.

Expiration, caused by the slackening of the muscles, the weight of the thorax, and the elasticity of the lungs. The triangularis sterni is a special depressor of the ribs, and some anatomists consider the internal intercostal muscles to be so also.

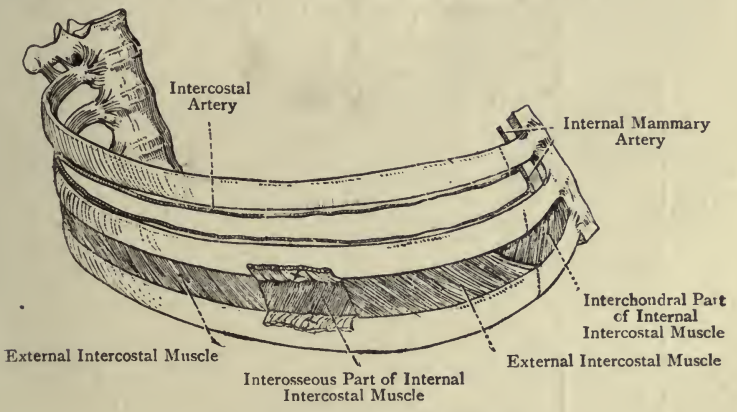


FIG. 37.—INTERCOSTAL MUSCLES.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Inspiration	External intercostal	From the lower border of the rib between the tubercle and the costal cartilage. The fibres go downwards and forwards in series with the fibres of the external oblique	The upper border of the rib below from the tubercle to the costal cartilage	Intercostal
The space in front over the costal cartilages is filled by the anterior intercostal aponeurosis				

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Inspiration (contd.)	Internal intercostal	From the lower border of the costal cartilage and inner edge of the subcostal groove; from the sternum to the angle of the rib. The fibres go downwards and backwards in series with the fibres of the internal oblique	The upper border of the rib below from the sternum to the angle of the rib	Intercostal
The	space beh	ind, between the angles	and the tubercles of the	ribs, is filled
		by the posterior intercos	tal aponeurosis	
	Scaleni	See Back Muscles		
	Serrati postici	See Back Muscles		
Depressors of the ribs in expiration	Triangularis sterni	From the back of the ensiform cartilage and sternum as high as the third costal cartilage.	The cartilages of the second to sixth ribs inclusive	Intercostal
	Internal intercostal	See above		
	Abdominal muscles	See Flexion of Spinal Column		

Several other muscles are used in acts of extraordinary or forced inspiration, namely:

Quadratus lumborum.
Pectorales major and minor.
Serratus magnus.
Latissimus dorsi.
Sterno-mastoid.
Extensors of the back.

The *Deep Fascia* of the trunk forms a complete investment for all the muscles. In the upper part of the body it is similar to the deep fascia of the limbs, forming an outside covering, and sending in septa between the muscles; but in the lumbar and abdominal regions it is rather more complicated.

The *Lumbar Fascia* is attached to the lumbar vertebræ in three layers—the outermost layer, to the spines; the middle layer, to the transverse processes; the innermost layer, to the bodies, near the roots of the transverse processes.

The outermost layer covers the dorsal surface of erector spinæ.

The middle layer lies between erector spinæ and quadratus lumborum.

The innermost layer covers the ventral surface of quadratus lumborum.

The middle layer then splits into two, so that four layers of fascia are formed for the three layers of abdominal muscles:

1. Covers the outer surface of external oblique.
2. Lies between external and internal oblique.
3. Lies between internal oblique and transversalis.
4. Covers the inner surface of transversalis.

At the outer border of rectus abdominis these four layers now join again to form two layers, which pass one in front of, the other behind, rectus abdominis, forming what is called the *sheath of the rectus;* this takes place in the upper three-fourths of the muscle. In the lower fourth both the layers of fascia pass in front of the rectus, so that on its ventral surface three-fourths of the way down there is a free edge of fascia, known as the fold of Douglas.

SECTION V

BONES AND MUSCLES OF HEAD

The term skull includes all the bones making up the head. This comprises the bones which enclose the brain—*i.e.*, the cranium, and the bones composing the skeleton of the face.

The bones of the cranium are—The occipital, sphenoid, ethmoid, frontal, the two parietals, and the two temporals.

The bones of the face are—The vomer, the mandible, and pairs of maxillæ, malar, palate, lachrymal, nasal, and inferior turbinate.

The hyoid bone is usually described with those of the skull.

All the bones of the head and face are joined together by immovable joints (sutures), except the mandible.

The skull, as a whole, is studied from five aspects—from the front, the side, the back, the top, and the base.

Norma Frontalis—the skull viewed from the front. This is limited above by the smooth convex upper part of the frontal bone, and below by the teeth of the upper jaw, if the mandible be disarticulated. The eye-sockets are formed by the lower part of the frontal bone, which in the middle articulates with the two nasal bones to form the bridge of the nose. The lower border of the eye-sockets is formed, internally, by the maxillæ and externally, by the malar bones, which give prominence to the cheeks. The two maxillæ articulate in the middle line below the nasal opening, to form the upper jaw; below hangs the mandible, or lower jaw, which articulates on each side by a very loose joint with the temporal bone.

Norma Lateralis (the side view of the skull).—In this view it can be seen distinctly which bones form the face and which the cranium. A line drawn from the middle of the lower border

of the frontal bone to the mastoid process of the temporal bone indicates the boundary. The cranium is of oval shape, with the long axis going backwards and downwards. The bones

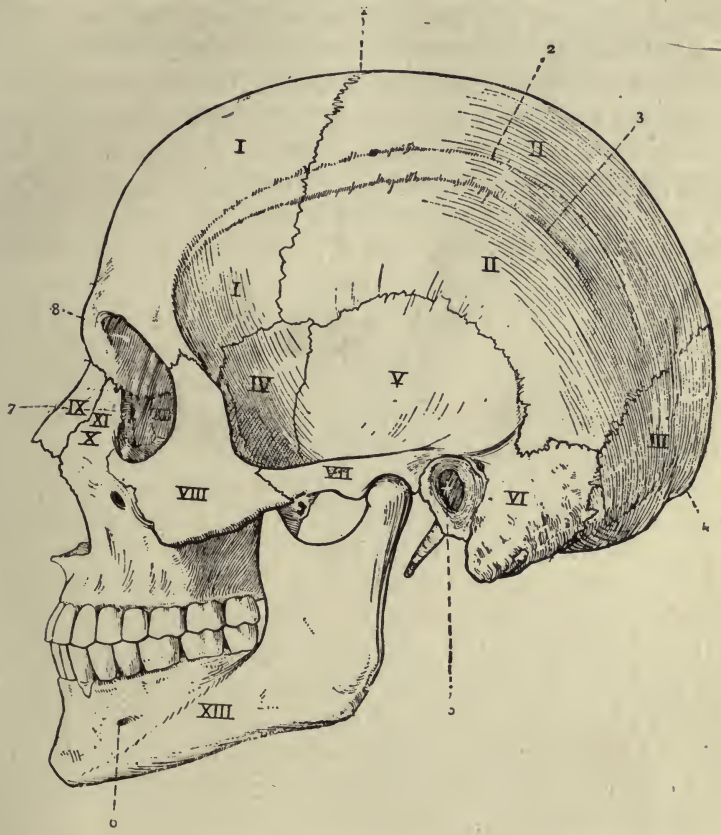


Fig. 38.—The Lateral Region of the Skull (Norma Lateralis).

I, I, Frontal; II, II, Parietal; III, Occipital; IV, Great Wing of Sphenoid; V, Squamous Portion of Temporal; VI, Mastoid Portion of Temporal; VII, Zygoma; VIII, Malar; IX, Nasal; X, Superior Maxilla (Nasal Process); XI, Lachrymal; XII, Ethmoid (Os Planum); XIII, Inferior Maxilla.

1, Bregma; 2, Superior Temporal Ridge; 3, Inferior Temporal Ridge; 4, Occipital Point; 5, Auricular Point; 6, Mental Foramen; 7, Lachrymal Groove; 8, Glabella.

composing it from before backwards, are—The frontal, parietal, temporal, and occipital. In this view it can also be seen that

the malar articulates with a process of the temporal. Between this process and the opening of the ear is the articulation of the mandible.

Norma Occipitalis (the back view of the skull) shows the rounded shape of the back of the head and the joints of the occipital and parietal bones, called the lambdoid suture.

Norma Verticalis (the view of the skull from above).—This varies very much with different individuals, and may be nearly circular or a long oval. The **T**-shaped sutures of the large bones forming the vault is seen: the two parietal bones join in the middle line; and anteriorly, where the parietals join the frontal, and posteriorly, where the parietals join the occipital, are situated the openings called the anterior and posterior fontanelles, found on the head at birth. These are due to the ossification of the several bones not being complete.

Norma Basalis (the view of the base of the skull, without the mandible).—In front is seen the row of upper teeth, between them being the processes of the maxillæ forming the roof of the mouth. Behind this is the sphenoid bone which, as it were, bolts together the whole skull underneath. The pterygoid plates, two on each side, hang down for the attachment of muscles, and the great wings of the sphenoid pass out on each side to articulate with the temporal bones. Articulating with the body of the sphenoid bone is the basilar process of the occipital bone, and behind this is seen the opening for the passage of the spinal cord. On each side of the opening are the prominent articular facets for articulation with the first vertebra. There are numerous foramina on the base of the skull for the passage of the cranial nerves.

The **Frontal** bone consists of three parts: a frontal part, forming the forehead; an orbital part, forming the upper margins of the eye-sockets; and a nasal part which helps to form the bridge of the nose.

The frontal part is convex in both its diameters, most marked just above the orbital margins.

The orbital part consists of the two rounded margins, separated from one another by the nasal notch. At the inner third of the margin is a deep groove, or may be a foramen, for the passage of

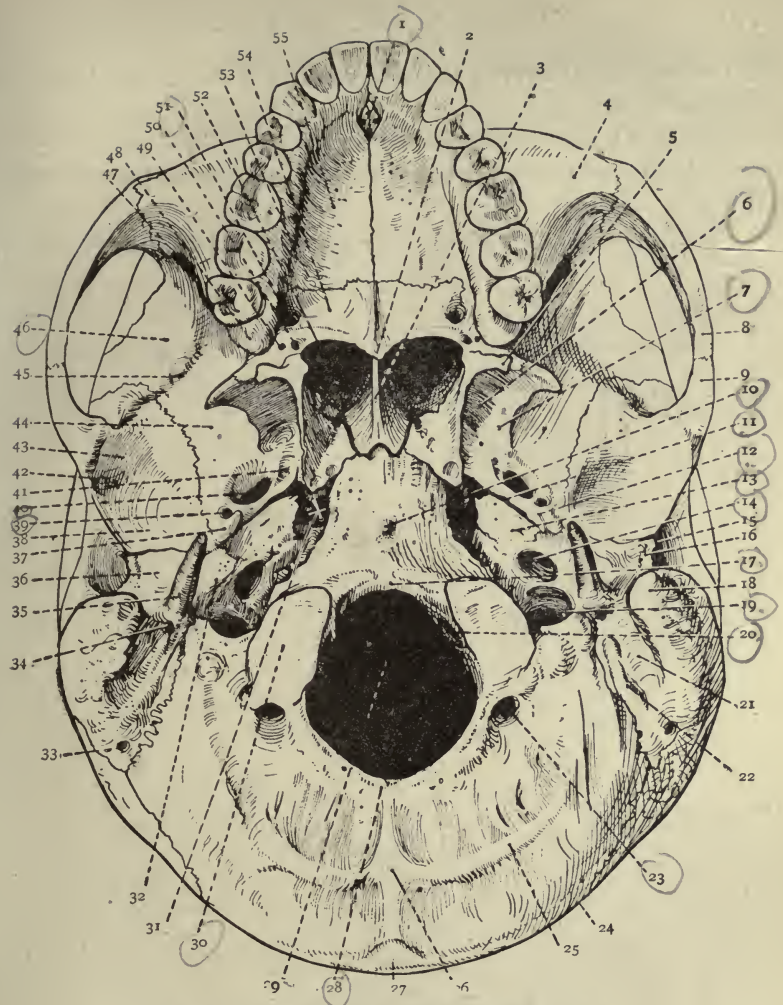


FIG. 39.—THE EXTERNAL BASE OF THE SKULL.

1. Ant. Palatine Fossa
2. Post. Nasal Spine
3. Post. Border of Vomer
4. Facial Surf. of Sup. Maxilla
5. Hamular Process of Int. Pterygoid Plate of Sphenoid
6. Pterygoid Fossa
7. Ext. Pterygoid Plate
8. Zygomatic Process of Malar
9. Zygoma of Temporal
10. Pharyngeal Tubercle (pointer crosses Foram. Lacerum Med.)
11. Eustachian Groove
12. Groove for Chorda Tympani Nerve
13. Petrous Portion of Temporal (Origin of Levator Palati)
14. Carotid Foramen
15. Ext. Auditory Meatus
16. Ext. Auditory Process
17. Basion
18. Mastoid Process
19. Jugular Foramen
20. Ant. Condylar Foramen
21. Digastric Groove
22. Occipital Groove
23. Post. Condylar Foramen
24. Sup Curved Line of Occipital
25. Inf. Curved Line
26. Ext. Occipital Crest
27. Ext. Occipital Protuberance
28. Opisthion
29. Foramen Magnum
30. Right Occipital Condyle
31. Foram. Lacerum Medium at +
32. Vaginal Proc. of Tymp. Plate
33. Mastoid Foramen
34. Stylo-Mastoid Foramen
35. Styloid Process
36. Tympanic Plate (Post. part of Glenoid Fossa)
37. Spinous Proc. of Sphenoid
38. Ant. part of Glenoid Fossa
39. Foramen Spinosum
40. Foramen Ovale
41. Foramen Vesalii
42. Preglenoid Tubercle
43. Eminentia Articularis
44. Zygomatic Fossa
45. Infratemporal Crest
46. Temporal Division of Great Wing of Sphenoid
47. Spheno-Maxillary Fissure
48. Tuberosity of Sup. Maxilla
49. Ext. Access. Palat. Foramen
50. Post. Access. Palat. Foramen
51. Post. Palatine Foramen
52. Right Post. Naris (pointer crosses ridge for Tensor Palati)
53. Groove for Descend. Palat. Artery
54. Horiz. Plate of Palate Bone
55. Palat. Proc. of Sup. Maxilla

the supra-orbital nerve; the margins end in the external angular processes.

The nasal part is roughened and projects backwards for the articulations of the nasal bones and other bones which are inside the face.

The frontal bone articulates with the parietal bones above,

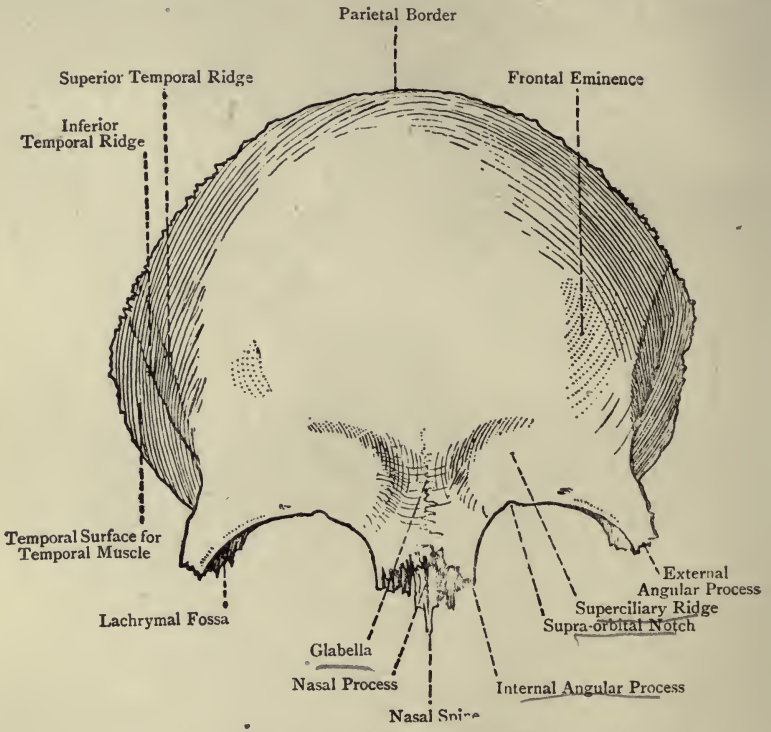


FIG. 40.—THE FRONTAL BONE.

with the malar bones by the outer extremities of the orbital margins, with the great wing of the sphenoid externally, just beyond the orbital margins.

The **Parietal** bones are two square-shaped bones, convex outwardly in both diameters. They articulate above with one another, anteriorly with the frontal bone, posteriorly with the occipital bone, and below with the temporal and sphenoid bones.

The **Occipital** bone consists of three parts arranged around the foramen magnum—a large hole for the passage of the spinal cord. The posterior part is triangular in shape, the apex being upwards, and is convex outwardly in both diameters. About the centre of this surface is a tubercle—the external occipital protu-

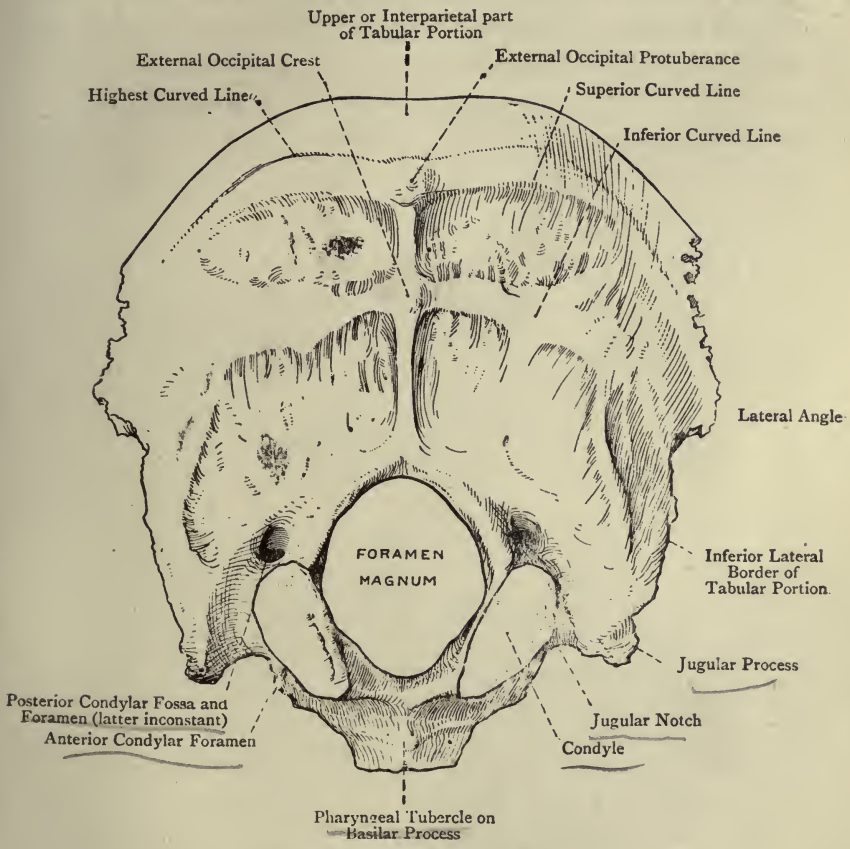


FIG. 41.—THE OCCIPITAL BONE.

berance—and from this curves out on each side the superior curved lines; a short distance below are the inferior curved lines. On each side of the foramen magnum are the condyles for articulation with the atlas. They are large oval masses of bone with an articulating surface convex in both directions;

in front and behind are found the anterior and posterior condylar foramina, the former of which transmits the hypoglossal nerve. The basilar process, in front of the foramen magnum, is a stout bar of bone articulating with the body of the sphenoid.

The occipital bone articulates with the two parietals above, with the sphenoid in front and below, externally with the temporals, and below with the atlas.

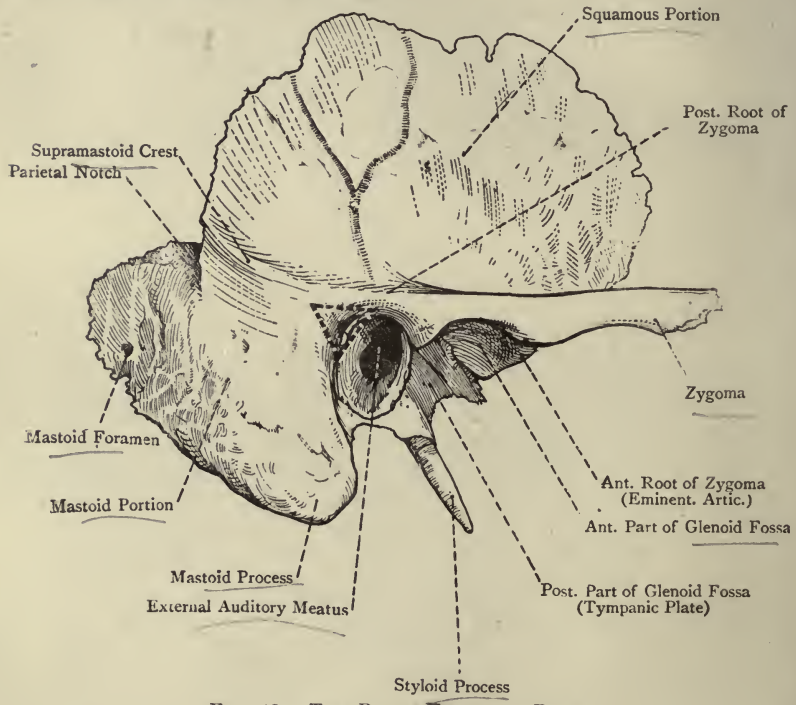


FIG. 42.—THE RIGHT TEMPORAL BONE.

The **Temporal** bone consists of a plate of bone, having on its lower border three processes. The inner part of the temporal bone supports the bony part of the ear, the aperture of which is seen just behind the root of the zygomatic process at the lower border of the squamous part (flat plate). The zygomatic process is a bar of bone projecting horizontally forwards. Just in front of the root is the surface for articulation with the

mandible and internal to the root; the styloid process, a slender process of bone, projects vertically downwards. The mastoid process is a stout conical-shaped process behind the opening of the ear, its apex pointing forwards and downwards.

The temporal bone articulates by means of the upper border of the squamous part with the sphenoid (great wing), parietal, and occipital bones, and by the zygomatic process with the malar bone.

The **Sphenoid** bone consists of a small body with several paired processes, the important ones being the great wings and the pterygoid plates. The latter, four in number, project downwards behind the nose. The great wings have at their extremities triangular surfaces, which articulate with the frontal, parietal, and temporal bones; these lock the sides of the cranium anteriorly. The body lies between the ethmoid (which articulates with the nasal parts of the frontal bone) and the basilar process of the occipital bone, so locks the cranium in the antero-posterior direction. The great wings also form part of the orbital cavity, and between the great wing and the lesser wing is the sphenoidal fissure at the back of the orbital cavity through which the first part of the fifth nerve passes. The foramen rotundum and foramen ovale are in the great wing.

Bones of the Face.

The **Maxillæ** unite to form the upper jaw; the body is pyramidal in form, and hollow, and has on it the infra-orbital foramen, through which part of the fifth nerve emerges. On the anterior border is a deep notch—the nasal notch; above the nasal notch the edge of the bone is rough to articulate with the nasal and frontal bones, below which it unites with its fellow of the opposite side. The inferior or alveolar border is ridged externally, and from it project the upper row of teeth; on the inner surface the palatal process, a flat plate of bone, projects horizontally inwards to form the roof of the mouth. The upper border is smooth and rounded, and forms the inner half of the lower border of the orbital margin, and ends in a rough process for articulation with the malar bone; the pos-

terior border is smooth and rounded, and hangs free at the back of the mouth. The hollow space enclosed is called the antrum of Highmore.

The maxilla articulates with the nasal, frontal, and malar bones, and its fellow of the opposite side.

The **Malar** bone, or cheek-bone, forms the most prominent part of the cheek; the bone is convex outwardly and more or

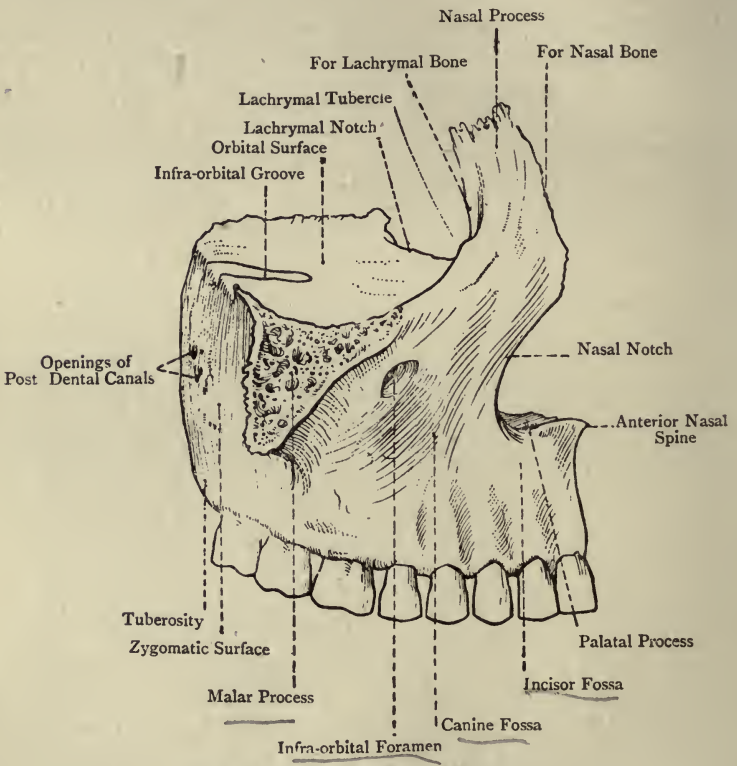


FIG. 43.—THE SUPERIOR MAXILLA.

less square in shape, three of the angles being prominent. The superior angle articulates with the external angular process of the frontal bone, and the upper half of the inner side of the malar bone forms the outer half of the lower border of the orbital margin; the lower half of the inner border articulates with the maxilla: the fourth angle articulates with the

zygomatic process of the temporal bone, completing the arch.

The **Mandible**, forming the lower jaw, is horseshoe in shape, with vertical processes at the ends. The body supports on its upper border the lower row of teeth, and near the middle line on the outer surface is the mental foramen through which the mental nerve emerges. In the middle line of the body a faint ridge can be seen, the symphysis, indicating that the bone was developed in two halves and fused in the middle line. On the

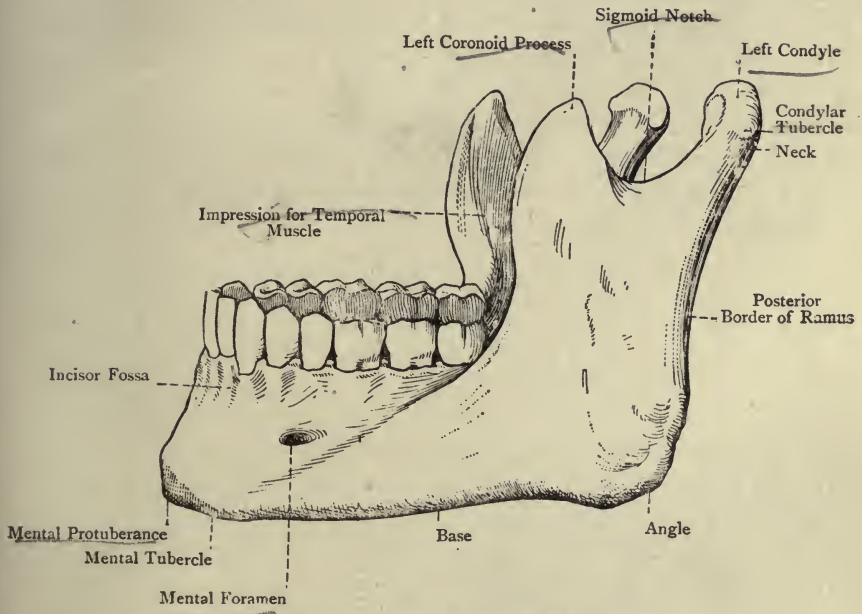


FIG. 44.—THE INFERIOR MAXILLA (MANDIBLE).

inferior border on each side of the symphysis is the digastric fossa, a small concave surface for the digastric muscle, and on the inner surface of the bone is found an oblique line or ridge. the mylo-hyoid ridge, slanting from above downwards and forwards.

The posterior vertical portions are called rami; they pass upwards from the posterior extremities of the body of the bone forming the angle of the jaw, which varies with different

individuals. On the inner surface of the bone is a large foramen for the inferior dental nerve, and overhanging it a small spur of bone, called the lingula. The ramus ends above in two processes—the coronoid anteriorly and the articular condyle posteriorly. Between them is a notch—the sigmoid notch.

The mandible articulates with the temporal bone.

The **Hyoid** bone is a small **U**-shaped bone lying between the mandible and the larynx, and connected to the skull by ligaments from the styloid process of the temporal bone; it is not articulated with any bones.

The bone consists of a small body with two large processes, the great cornua projecting backwards and, where the great cornua join the body, two small pointed processes, the lesser cornua, projecting obliquely upwards.

The hyoid bone has a large number of muscles attached to it, and owing to its loose connection with the skull gives great mobility to this region.

Joints of the Skull.

All the joints of the head and face, with the exception of the temporo-mandibular, are sutures. These are immovable joints formed by dentated edges fitted together and firmly united by means of cartilage.

Temporo-Mandibular Joint between the condyle of the mandible and the articular hollow at the root of the zygomatic process of the temporal bone.

The joint is a very movable one, the condyle being almost cylindrical in shape, with its long axis directed outwards and forwards. The articular or glenoid fossa is saddle-shaped, being concavo-convex from behind forwards. The joint is divided into an upper and lower part by a meniscus of fibro-cartilage, which compensates for the difference in shape of the two surfaces.

Owing to this construction the joint is particularly movable, and the two joints need not always act simultaneously, but can do so alternately, which gives a lateral movement to the jaw. The movements possible are—

Transverse axis—raising and depressing of mandible.

During depression—protrusion and retraction.

Alternate—lateral motion.

A combination of all these movements produces a rotatory movement of the jaw.

Ligaments.—A *capsule* surrounds the joint completely, but internally it is very thin; it is attached to the meniscus all round.

Temporo-Mandibular ligament from the outer half of the lower border of the zygoma to the posterior border and lateral

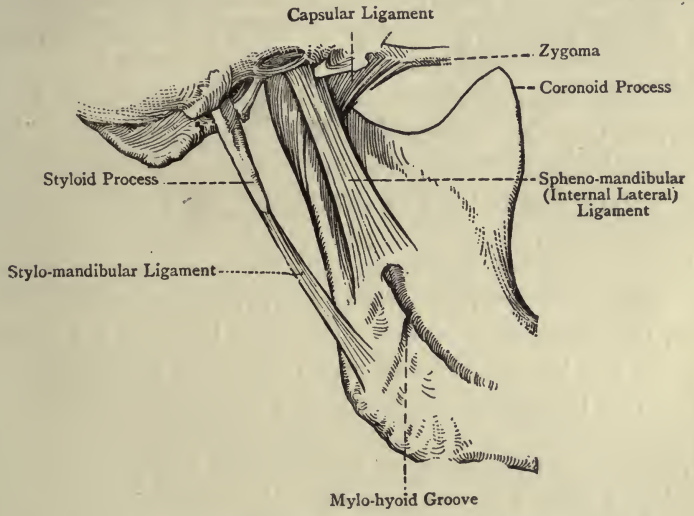


FIG. 45.—THE TEMPORO-MANDIBULAR JOINT.

surface of the neck of the mandible (the part supporting the condyle).

A *synovial membrane* lines both compartments of the joint, which may be continuous through a perforation in the cartilage.

Accessory Ligaments: Spheno-mandibular from the spinous process of the great wing of the sphenoid bone to the lingula on the inner surface of the mandible.

Stylo-Mandibular, from the tip of the styloid process of the temporal bone to the posterior border of the angle of the mandible.

Articulation of Skull with Spinal Column.

The skull articulates with the spinal column by means of the condyles of the occipital bone and the articular facets on the lateral masses of the atlas. The condyles are convex in both lateral directions, and the facets concave, so the joint is freely movable round two axes.

Transverse—flexion and extension.

Antero-posterior—lateral flexion.

A combination of these movements causes rotation or "rolling."

A *capsule*, which is complete, surrounds both the joints.

A *synovial membrane* lines both the joint cavities.

Accessory Ligaments.—These are very numerous and more important than the ligaments of the actual joints.

Odontoid ligaments, are three in number, one from the apex of the odontoid peg and one on either side; these latter are called check ligaments.

Occipito-Atlantoid ligaments, anterior and posterior; their membranous structure continuous with the capsules of the joints, thus forming a complete ligament between the foramen magnum and the anterior and posterior arches of the atlas.

Posterior Occipito-Axoid ligament, a continuation upwards of the posterior longitudinal ligament.

Ligamentum Cruciatum, a cross-shaped ligament, the horizontal part formed by the transverse ligament of the atlas, the vertical bars being attached to the occipital bone and axis respectively.

Muscles acting on the Joints of the Skull.

The muscles of the head and face are divided into four sets:

1. Muscles of the scalp.
2. Muscles of expression.
3. Muscles of mastication.
4. Muscles connecting the skull to the spinal column.

1. The **Muscles of the Scalp** are the occipito-frontalis muscle and the muscles of the external ear.

The **Occipito-Frontalis** muscle does not act on any joint.

The posterior part of the muscle fibres, arising from the outer two-thirds of the superior curved line of the occipital bone, are inserted into the epicranial aponeurosis; the anterior part arises from the epicranial aponeurosis and blends with muscles round the orbital margins.

The epicranial aponeurosis is a thick fascial membrane attached posteriorly to the superior curved lines of the occipital bone, laterally to the temporal bone; anteriorly, it blends with the deep fascia.

Nerve-supply—facial.

2. The **Muscles of Expression** are a large number of small muscles in the face which generally have bony origins, but are inserted into the fascia or blend with other muscles; they are in three groups, associated with the eye, the nose, and the mouth.

Nerve supply—facial.

3. The **Muscles of Mastication** are those acting on the temporo-mandibular joint, causing movement of the lower jaw; the muscles which depress the lower jaw are muscles of the neck, not true muscles of mastication.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Raising or closing of the jaw	Masseter	From the anterior two-thirds of the lower border of the zygoma and the inner surface in its whole length	The outer surface of the ramus and angle of the lower jaw	Inferior maxillary division of the fifth
	Temporal	The whole of the temporal fossa and fascia covering it	The inner surface and apex of coronoid process and anterior border of the ramus of the lower jaw	Same as above
	Internal pterygoid	From the inner surface of the external pterygoid plate and from the tuberosity of the maxilla	The inner surface of the angle of the lower jaw	Same as above
Protrusion	External pterygoid	From the under surface of the great wing of the sphenoid and the outer surface of the external pterygoid plate	The anterior border of the neck of the lower jaw, the inter-articular cartilage, and the capsule	Same as above
	Internal pterygoid	See above		

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Protrusion (*contd.*)	Temporal (anterior fibres)	From the under surface of the great wing of the sphenoid and the outer surface of the external pterygoid plate		
Retraction	Temporal (posterior fibres)	See above		
Lateral movement	External / Internal	Pterygoid of one side		

The **Buccinator** muscle is also a muscle of mastication, but has no action on the jaw; it is the muscle of the cheek, and by its contraction prevents food from collecting on one side.

Muscle.	Origin.	Insertion.	Nerve-supply.
Buccinator	From the alveolar arches of the upper and lower jaw and from the pterigo-mandibular ligament	The fibres pass forward and blend with the muscles round the mouth	Branches from both fifth and seventh nerves

MUSCLES OF THE NECK WHICH DEPRESS THE LOWER JAW.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Depression	Digastric	Posterior belly from the digastric groove in front of the mastoid process. This ends in a tendon which is connected by a band of fascia to the body of the hyoid bone. The anterior belly arises from this, and is directed forwards and upwards	The oval impression on the lower border of the mandible close to the symphysis	Branch from inferior dental
	Suprahyoid muscles—*i.e.*, those which have their origins on the lower jaw, and are inserted into the hyoid bone			

4. The muscles causing **Movements of the Head**—*i.e.*, those connecting the skull to the spinal column.

(1) Flexion and extension—the muscles of both sides acting together.

Action.	Muscle.	Origin.	Insertion.	Nerve-supply.
Flexion	Depressor	s of the jaw when tempo	ro-mandibular joint is fix	ed
	Infrahyoi	d muscles—*i.e.*, between	hyoid bone and sternum	
	Recti capi on the l	tis antici major and min esser cervical vertebræ a process of the	or, small muscles having nd their insertions on th occipital bone	their origins e basilar
Exten-sion	Sterno-mastoid	From the anterior surface of the manubrium sterni and the inner third of the upper border of the clavicle	The outer surface of the mastoid process and the superior curved line of the occipital bone	Spinal accessory
	Splenius capitis	See Extension of Spinal	Column	
	Com-plexus	See Extension of Spinal	Column	
	Obliquus inferior	From the spine of the axis	The transverse process of the atlas	Post primary divisions
	Rectus ca atlas	pitis posticus major and to the occipital bone be	minor from the spine of hind the foramen magn	the axis and um

(2) Lateral movement—the muscles of one side acting alone.

Action.	Muscle.	Origin.	Insertion.
Lateral flexion	Sterno-mastoid	See Extension	
	Splenius capitis	See Extension	
	Com-plexus	See Extension	
	Obliquus superior	From the transverse process of the atlas	The occipital bone beneath complexus
	Rectus ca from the s	pitis lateralis, a small m the transverse process of ide of the foramen magn	uscle in series with the other recti the atlas to the occipital bone at um
Rotation	Sterno-m	astoid	
	Splenius	capitis	
	Complexu	s	
	Recti capi	ti postici (major and mi	nor)
	Obliqui	(superior and inferior)	

SECTION VI

THE DIGESTIVE SYSTEM

The digestive system includes the alimentary canal and various organs connected with it. The greater part of the digestive system lies within the abdomen. The alimentary canal consists of the following parts: Mouth, pharynx, œsophagus, stomach, duodenum, small intestine (jejunum, ileum), large intestine, rectum; and the organs connected with it are—salivary glands, liver, pancreas. The whole of the alimentary canal consists of structures formed of one or more muscular coats lined with mucous membrane.

The **Mouth** is the first division of the alimentary canal, and contains the parts necessary for mastication and the openings of the ducts of the salivary glands. The food passes from the mouth into the pharynx, a large space at the back of the nose and mouth, containing in its lower half the greater part of the tongue and the larynx. The pharynx ends at the level of the sixth cervical vertebra, and from it pass the larynx and trachea in front and the œsophagus behind.

The **Œsophagus** is the part of the digestive canal which leads from the pharynx to the stomach. It is a muscular tube, flattened by the trachea and the other structures lying on it. It lies in the thorax and extends from the sixth cervical vertebra to the eleventh dorsal vertebra, where it passes through the diaphragm and enters the stomach. It is closely applied to the vertebral column, lying behind the other structures in the thorax.

The **Abdominal Cavity,** which contains the rest of the alimentary canal, is bounded above by the diaphragm, below by the pelvic floor, posteriorly by the lumbar vertebræ, and

anteriorly and laterally by the abdominal muscles and iliac bones. The false pelvis is included in the abdominal cavity. The abdomen is divided up into nine regions by two horizontal lines and two vertical lines.

The subcostal line, the upper of the two horizontal ones, is drawn round the trunk at the level of the lower border of the tenth costal cartilage. The intertubercular line—the lower horizontal one—is drawn at the level of the tubercles on the crests of the iliac bones, about two inches behind the anterior superior spine. This is the highest point of the iliac crests. The vertical or Poupart's lines are drawn from a point midway between the anterior superior spine of the ilium and the symphysis of the pubis.

By this means we have three regions in the middle line—the epigastric, umbilical, and hypogastric, and laterally the hypochondrium, lumbar, and iliac regions.

The **Peritoneum** is a serous sac which lines the abdominal cavity and invests all the structures. It is a thin membrane, secreting sufficient fluid to keep the whole surface lubricated and to enable the organs to move easily over one another. The peritoneum is really one sac, and its arrangement is very complicated, as it invests all the organs and connects them with the abdominal wall.

The connections of the organs to the abdominal wall and to one another are called by three different names:

Omenta—folds of peritoneum connecting the stomach with any other organ.

Mesenteries—folds of peritoneum connecting the intestines with the abdominal wall.

Ligaments—folds of peritoneum connecting organs (not parts of the alimentary canal) to one another or to the abdominal wall.

Following the peritoneum up the anterior abdominal wall, it passes over the under surface of the diaphragm; from the posterior edge of that it is reflected back over the upper surface of the liver. It then turns round the anterior edge of the liver and, forming the anterior fold of the small omentum, meets the stomach; it covers the anterior surface of the stomach and hangs

down in a large fold called the great omentum. The posterior fold of the great omentum passes up over the posterior surface of the colon, where it is carried by the vessels to the posterior abdominal wall, and is carried off that, by the vessels, in a fan-shaped process—the mesentery—which invests the small intestine. After passing round the small intestine it again goes back to the posterior abdominal wall, where it passes down over the

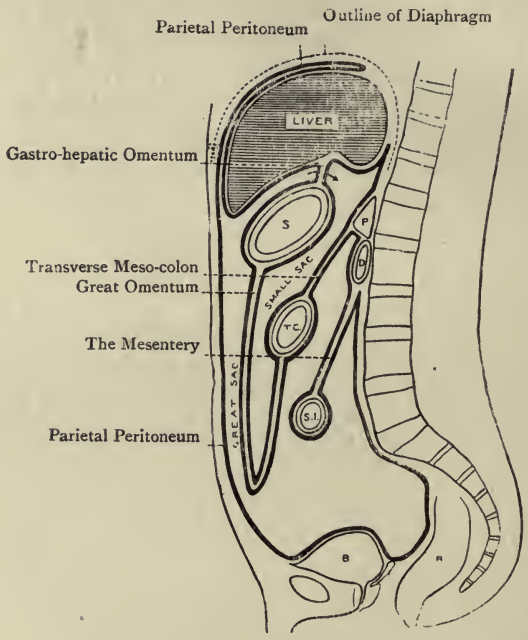


FIG. 46.—THE PERITONEUM.

rectum and the upper part of the pelvic organs to the anterior abdominal wall. This constitutes the great sac of the peritoneum. The small sac covers the posterior half of the under surface of the liver, forms the posterior fold of the small omentum, and covers the posterior surface of the stomach; it then forms a fold inside that of the great omentum, and passes up over the anterior surface of the colon, back to the posterior abdominal wall.

The **Stomach** is a pyriform sac with two openings—the œsophageal or cardiac, opening, and the pylorus, opening into the duodenum. The stomach has two ends, two surfaces, two curvatures, and two openings.

The large cardiac end is directed backwards and to the left and the narrow pyloric end is directed to the right. The stomach lies in the left hypochondrium and left half of the epigastrium, under the left cupola of the diaphragm. In extreme extension it may reach down below the subcostal plane.

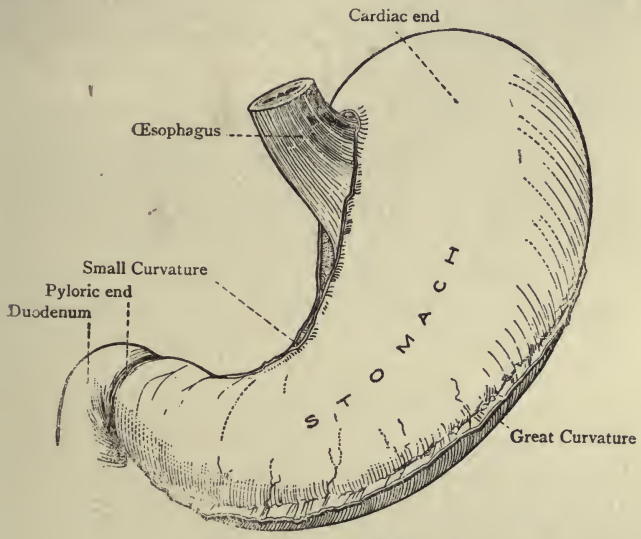


FIG. 47.—THE STOMACH.

The length of the stomach is 10 to 11 inches and its greatest diameter 4 to 4½ inches; its capacity as a rule does not exceed 40 ounces (1 quart).

The stomach is composed of three layers of muscles with their fibres running in different directions, which insures thorough contractions of all parts taking place during digestion. When empty, the stomach in the healthy state is not collapsed, but contracted.

The stomach lies in a cavity surrounded by other organs, and to this cavity is often given the name of the stomach chamber.

The Stomach Chamber.—The roof is formed of the under surface of the left lobe of the liver and the left cupola of the diaphragm; this latter slopes down behind and forms the posterior wall. The anterior wall is formed by the abdominal wall between the ribs on the left and the liver on the right. The floor on which the stomach rests is formed by the top of the left kidney and suprarenal capsule, the gastric surface of the spleen, upper surface of the pancreas, and coils of small intestine.

The **Intestines** are divided into three parts—the duodenum; the small intestine, consisting of jejunum and ileum; and the large intestine. The structure of the duodenum and small intestine is alike; they consist of two muscular coats—an inner circular layer and an outer longitudinal layer. The mucous membrane is covered by a number of *villi,* small processes about $\frac{1}{40}$ inch long, and closely set all over the surface; they are for the purposes of absorption. In order to increase the surface, the mucous membrane is arranged in a series of circular folds called *valvulæ conniventes.* On the surface of the mucous membrane are found also *Peyer's patches,* which are small aggregations of lymphoid tissue about $\frac{1}{2}$ inch long; there are about thirty-five to forty of them usually found, most marked in young subjects.

The **Duodenum** is really the first part of the small intestine, and starts at the pyloric orifice of the stomach, on the left side of the body of the first lumbar vertebra. It is a **C**-shaped organ, closely applied to the back wall of the abdomen. It starts at the level of the first lumbar vertebra, passes downwards and to the right as low down as the third lumbar vertebra and, turning upwards, ends on the left side of the body of the second lumbar vertebra at the duodeno-jejunal flexure, being the point at which the jejunum, or second part of the small intestine, begins.

In the curve of the duodenum lies the head of the pancreas, the body passing to the left between the two ends. The duodenum lies on the vena cava and aorta and the two psoas muscles. It touches the right kidney, and is covered by coils of small intestine.

On the inner surface of the duodenum just behind the pylorus is seen a small prominence—the bile papilla—on which is the common opening of the bile and pancreatic ducts.

The **Jejunum** is the second part of the small intestine, and the *Ileum* is the third part. They measure about 20 feet together, and start at the duodeno-jejunal flexure, ending by the junction of the ileum with the large intestine at the colic valve.

The coils of the small intestine lie in the abdominal cavity, varying considerably in their disposition, as they are in continual movement.

There is very little difference between the jejunum and ileum, and the transition of one to the other is gradual. The ileum is smaller in diameter, has fewer valvulæ conniventes and a larger number of Peyer's patches than the jejunum.

The **Large Intestine** consists of several parts—the cæcum, ascending, transverse, and descending colons, sigmoid flexure of colon, and rectum.

The structure is similar to that of the small intestine except that it has no villi and the longitudinal coat of muscle consists of three longitudinal bands, so that the organ has a sacculated appearance.

Small processes of peritoneum distended with fat called *appendices epiploicæ* hang from the outer wall of the large intestine.

The **Cæcum** is a small sac about $2\frac{1}{2}$ inches long and 3 inches wide which forms the blind end of the large intestine and lies below the colic valve, or entrance of the ileum into the large intestine; it lies in the right iliac fossa in front of the psoas muscle. Just below the colic valve, the appendix opens out from the cæcum. It is a small blind process, very often with no lumen at all, about $3\frac{1}{2}$ inches long; it lies behind the cæcum, generally pointing upwards and to the left, but the position is very variable.

The **Ascending Colon** (length about 8 inches) is the continuation upwards of the cæcum. It lies in the groove between the right psoas and quadratus lumborum, and the front of the right kidney. When it reaches the liver it forms the hepatic flexure by bending at an angle to the left and is continued as—

The **Transverse Colon** (length about 20 inches) which forms a loop across the abdomen. It passes in front of the duodenum and pancreas and behind the stomach; it then passes upwards and backwards until it reaches the base of the spleen, where it forms the splenic flexure by turning sharply downwards and becoming—

The **Descending Colon** (length about 6 inches). It lies on the front of the left kidney, then in the groove between psoas and quadratus lumborum. It is covered by coils of small intestine.

The **Sigmoid Flexure,** or iliac and pelvic colons, are the continuation of the descending colon. The latter ends at the iliac crest and is continued as the iliac colon, which crosses the left iliac fossa; then entering the true pelvis crosses over to the right and back to the middle line, where it is continued as the rectum, beginning at the level of the third sacral vertebra.

The **Rectum** is the dilated end of the large intestine, ending in the anal canal, at a point just below the level of the tip of the coccyx and 1½ inches in front of it. It is an **S**-shaped organ about 6 inches long, and closely follows the curve of the sacrum. The anal canal is about 1 inch long, and is a slit-like passage passing between the two levator ani muscles, which, joining in the middle line, form the floor of the pelvis.

The **Digestive Glands** consist of the salivary glands, of which there are three pairs; the liver; and the pancreas.

The **Parotid Gland,** the largest of the three, lies in a hollow just in front of the ear. Above, it reaches up to the zygoma and is intimately associated with the temporo-mandibular joint. Anteriorly, a process of the gland passes forwards over the masseter muscle. It extends as far down as the angle of the jaw and slightly backwards over the sterno-mastoid muscle.

The duct (Stenson's) leaves the gland at the anterior border, passes forwards over the masseter, and pierces the buccinator to reach the inside of the mouth.

The facial nerve passes through the parotid gland and in its substance breaks up into branches.

The **Submaxillary Gland** is the next largest; it lies in a recess

just inside the angle of the mandible. It lies on the mylohyoid muscle and posteriorly is in contact with the sterno-mastoid muscle.

The duct (Wharton's) leaves the deep surface of the gland and passing forwards beneath the mylohyoid muscle pierces the floor of the mouth under the tongue.

The **Sublingual Gland** is a small gland which lies on the floor of the mouth under the tongue, covered only by mucous membrane.

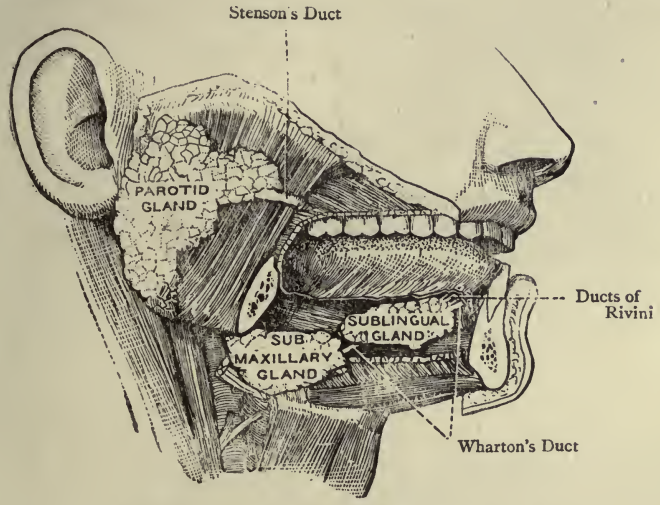


FIG. 48.—THE SALIVARY GLANDS.

The ducts (of Rivini) are numerous and small, and pierce the mucous membrane covering the gland.

The **Liver** is the largest of all the digestive glands. It lies beneath the right cupola of the diaphragm and against the ribs on the right side of the body. Its function is to secrete the bile, which is carried to the duodenum by the bile-duct. On the bile-duct is a small diverticulum—the gall bladder—in which the bile is stored until required.

The liver lies mainly in the right hypochondrium, but the thin left side of it reaches as far as the left Poupart plane. Its lower border extends from the sixth costal cartilage on the left side to the tenth rib on the right side; it very often extends

downwards a little lower on the right side. The upper limit, anteriorly, corresponds with the line of the diaphragm—*i.e.*, the fifth intercostal space on the right, and the sixth costal cartilage on the left, with a depression in the middle. The mass of the liver is divided into right and left lobes by the falciform ligament, a fold of peritoneum connecting the liver with the anterior abdominal wall and diaphragm.

The liver has two surfaces — visceral and parietal. The *Parietal* surface lies above, against the diaphragm—anteriorly,

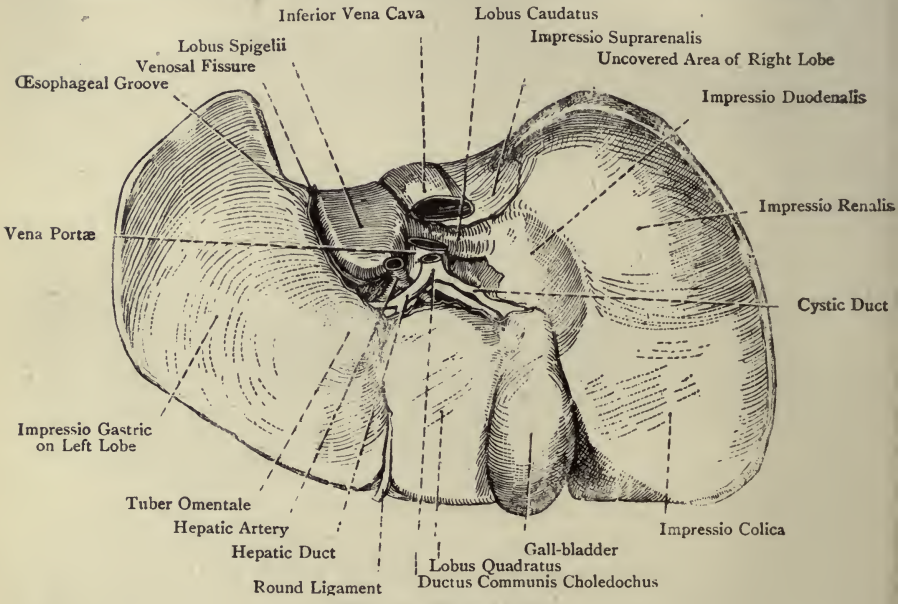


FIG. 49.—THE LIVER.

against the abdominal wall, laterally, against the ribs, from which it is separated by the diaphragm, posteriorly, also against the diaphragm. The whole of the liver is covered by peritoneum except a small portion of the posterior surface known as the "uncovered area," which is in direct relation with the diaphragm.

The "uncovered area" is a small portion of the liver which lies between the two coronary ligaments, the folds of peritoneum passing from the liver to the abdominal wall. On the "un-

covered area" is a small triangular impression made by the right suprarenal capsule, and to the left of this a deep groove into which fits the vena cava. To the left of the vena cava lies the Spigelian lobe, a small prominent portion of liver substance. To the left of the Spigelian lobe lies the groove for the œsophagus.

The *Visceral* surface is a sloping surface looking obliquely downwards, backwards, and to the left. It lies upon the stomach, intestines, and right kidney.

The visceral surface of the left lobe lies on the cardiac portion of the stomach and the lesser curvature where the small omentum is attached. The stomach makes a deep concave impression on the liver, and above, the liver substance bulges out, forming the omental tuberosity. The visceral surface of the right lobe is divided into two portions by the gall-bladder, the portion on the left being called the quadrate lobe. Between the left lobe and the quadrate lobe is the portal fissure, to which the small omentum is attached. In the portal fissure lie the portal vein, hepatic veins, and hepatic artery. On the right of the gall bladder are three impressions—that of the duodenum just above, and to the right that of the right kidney, and below, the hepatic flexure of the colon (see Fig. 49).

The *Hepatic Duct* is formed by the union of the ducts from the right and left lobes, and joined by the cystic duct from the common bile-duct, which lies in the portal fissure.

The *Gall-Bladder* is a diverticulum of the bile-duct to form a reservoir for the bile. It is a pear-shaped bag, the wide end of which usually protrudes below the inferior border of the liver and touches the abdominal wall at the level of the ninth costal cartilage on the right side.

The **Pancreas** is a long, narrow gland lying transversely on the posterior abdominal wall. It has no true capsule, so the lobulations are apparent. In shape the pancreas can be compared to a J turned on its side thus ⊂. It is divisible into a head, body, and tail. The head lies in the curve of the duodenum, the body on the posterior abdominal wall crossing in front of the left kidney, and the tail comes in contact with the spleen. Behind the head of the pancreas are the vena cava and

aorta. The upper surface of the body is wide (in transverse section the body is triangular), and forms part of the floor of the stomach chamber, and the anterior surface is in relation with the coils of the small intestine.

The whole of the pancreas is covered by peritoneum, except the posterior surface, which is closely applied to the abdominal wall and kidney.

The *Pancreatic Duct* commences at the tail of the organ. It emerges at the head, and, meeting the bile-duct, the two pierce the wall of the duodenum and open by a common orifice.

SECTION VII

THE DUCTLESS GLANDS, KIDNEYS AND PELVIC ORGANS

The **Ductless Glands** are a number of organs in different parts of the body, which, as their name implies, have no ducts, but pour their "internal secretion" direct into the vascular system. The principal ones are the lymphatic glands, the thyroid gland, suprarenal capsules, and spleen.

The **Thyroid Gland** is a very vascular structure situated at the upper end of the trachea, and extending upwards on the sides of the larynx. It consists of three parts, two lateral lobes joined in the middle line by the body. It is always relatively larger in the female and child than in the male.

The lateral lobe is triangular in shape, the base extends as far down as the fifth or sixth ring of the trachea, and the apex reaches up to the side of the thyroid cartilage. It is covered by some of the infrahyoid muscles and the sterno-mastoid muscle, and posteriorly it touches the œsophagus and common carotid artery.

The body is a narrow band uniting the lower ends of the lateral lobes and lying on the second and third rings of the trachea.

The **Spleen** is one of the abdominal organs, but not connected with digestion. It is the largest of the ductless glands.

It lies in the left hypochondrium in the mid-axillary line reaching from the upper border of the ninth rib to the upper border of the twelfth, its long axis being in the same direction as that of the tenth rib. It has an irregular shape. The outer surface is convex and more or less oval, and closely applied to the diaphragm which separates it from the ribs. The visceral surface is divided into three parts by ridges, which join to form a more

or less prominent apex in the centre. The upper and largest part has a deep concave impression formed by the stomach; the two lower parts are in contact respectively with the left kidney and the splenic flexure of the colon. At the lower border of the gastric impression is the hilus, where the bloodvessels and nerves enter, and just below this is the impression made by the tail of the pancreas.

The spleen is almost completely covered by peritoneum, and two folds pass from it connecting it with the stomach and kidney, called, respectively, the gastro-splenic and lieno-renal ligaments.

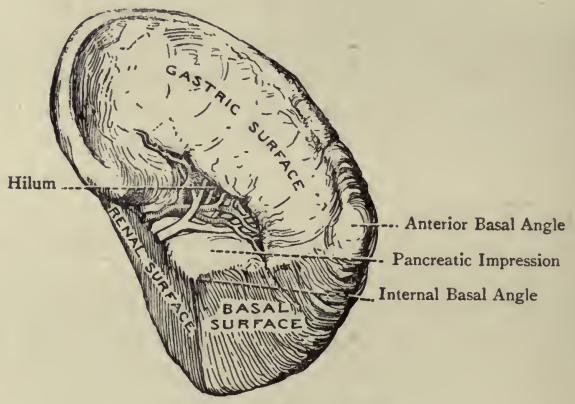


FIG. 50.—THE SPLEEN.

The **Suprarenal Capsules** are two small triangular bodies resting on the upper ends of the kidneys.

The *right suprarenal capsule* is in contact anteriorly with the vena cava and the liver; posteriorly it is in contact with the diaphragm, and its inferior surface rests on the anterior internal aspect of the upper end of the kidney. The peritoneum covers a very small portion of the anterior surface.

The *left suprarenal capsule* has a rounded apex, so is more semilunar than triangular. It is also placed lower down on the inner border of the left kidney instead of on the upper end. The greater part of the anterior surface is in contact with the stomach, and is covered with peritoneum; the lower remaining part is behind the pancreas. Posteriorly the left suprarenal

capsule is in contact with the left crus of the diaphragm and the inner border of the kidney.

The **Kidneys** are a pair of organs placed on the posterior wall of the abdomen, which secrete the urine: the urine is carried by means of the ureter to the bladder, situated in the pelvis, which opens to the exterior by means of the urethra.

They are bean-shaped organs lying on the posterior wall of the abdomen, with their long axes vertical and the hilus placed towards the middle line. The position of the kidneys varies somewhat with the individual, but as a rule the right kidney is at a lower level than the left. The greater part of the kidneys lies to the inner side of a line drawn vertically upwards from the mid-point of Poupart's ligament (this is not the same as the mid-Poupart plane). The posterior surface of the kidney is closely applied to the diaphragm, psoas, and quadratus lumborum muscles, and tendon of transversalis in front of the twelfth rib and transverse processes of the first three lumbar vertebræ. The lower end is usually from $1\frac{1}{4}$ to 2 inches above the crest of the ilium, and is farther from the middle line than the upper. The kidneys lie entirely behind the peritoneum, and are held in position by a quantity of fat. The kidney is slightly rotated in position so that the hilus projects forward.

On the upper end of each kidney is a ductless gland, the suprarenal capsule (described above).

The relations of the anterior surface differ on the two kidneys. The right kidney has on its anterior surface, above and internally, the suprarenal capsule. Below that a large part of the surface is in contact with the visceral portion of the liver, and below that the kidney is in contact with the duodenum and the beginning of the transverse colon.

On the anterior surface of the left kidney, above and internally, is the impression of the suprarenal capsule; just below is a small surface in contact with the stomach, and below again the pancreatic surface. To the right of these there is the gastric surface, and the lower end is in contact with the jejunum internally and the transverse colon externally.

At the hilus below the renal artery is the pelvis of the

kidney—a thin-walled funnel-shaped sac formed by the junction of several calyces inside the kidney; the pelvis rapidly narrows to form the ureter.

The *Ureter* is a duct with a small lumen and thick muscular walls. It is about 9 inches in length. The upper half or rather more lies in the abdominal cavity, the rest in the pelvis. The ureter passes downwards and inwards lying on psoas, and, crossing the iliac artery, it enters the pelvis. It then passes down on the side wall of the pelvis under the peritoneum, curving backwards close to the great sciatic notch. At the level of the ischial spine it bends inwards and enters the bladder about an inch from the middle line.

The Pelvic Organs.—The pelvis contains the bladder, the rectum, and the internal genital organs. The bladder lies anteriorly close against the pubic bones, the rectum posteriorly close against the sacrum (see Section VI.), and the internal genital organs between the two. They are all covered superiorly by peritoneum.

The bladder is a hollow organ with muscular walls capable of great distension. When empty and contracted, it lies entirely in the pelvis just behind the symphysis pubis; when distended, it rises above the pelvis into the abdominal cavity. Superiorly it is covered by peritoneum reflected from the anterior abdominal wall and the sides of the pelvis, and is in relation with the coils of the small intestine. The under surface lies on the symphysis pubis and the bodies of the pubic bones; externally it is in contact with the levator ani and obturator internus muscles on each side. Posteriorly it is separated from the rectum by the uterus and vagina in the female, and the seminal vesicles in the male. The lower part of the bladder only moves in position very slightly; during distension the side and upper walls expand and rise into the abdominal cavity. In the posterior wall of the bladder are the openings of the two ureters and the urethra. The three openings form an equilateral triangle with the apex downwards and the sides are about 1 inch long.

SECTION VIII

THE RESPIRATORY ORGANS

The **Organs of Respiration** are the lungs and trachea, the latter being the passage by means of which air is carried from the pharynx to the lungs.

Breathing consists of the acts of inspiration and expiration; in the former, air is drawn into the pharynx through either the nose or mouth and conveyed by means of the trachea to the lungs; the air is expelled in the same way.

The upper part of the air passage, the larynx, is specially modified by cartilages and muscles to produce sounds—*i.e.*, the voice—during expiration.

The **Pharynx** is a large space behind the nose and mouth in the lower part of which are the openings of the larynx and œsophagus; the pharynx is compressed laterally, and its anterior wall is practically non-existent, the lateral walls being attached to the sides of the nasal, buccal and laryngeal orifices. The posterior wall is attached by areolar tissue to the muscles in front of the first six cervical vertebræ, and above, it is attached to the basilar process of the occipital bone and to the temporal bones.

The upper part of the pharynx is almost separated off from the lower part by the soft palate, which projects backwards from the palatal processes of the maxillary bones, and in this upper part is found the orifices of the Eustachian tube and the pharyngeal tonsil. Below the soft palate is the tonsil on each side. Below this the pharynx rapidly narrows as it passss the opening of the larynx and becomes the œsophagus.

The **Larynx** is the upper part of the air passage, and is placed in front of the fourth, fifth, and sixth cervical vertebræ. It con-

sists of several cartilages held together by muscles. The largest—the thyroid cartilage—cousists of two large plates of cartilage joined at an angle in the middle line; in the male this angle is about 90 degrees, and projects forward, forming what is called the "Adam's apple." Below the thyroid cartilage is the cricoid cartilage, in shape like a signet ring with the narrow part in front. The interval between the two can easily be felt in the

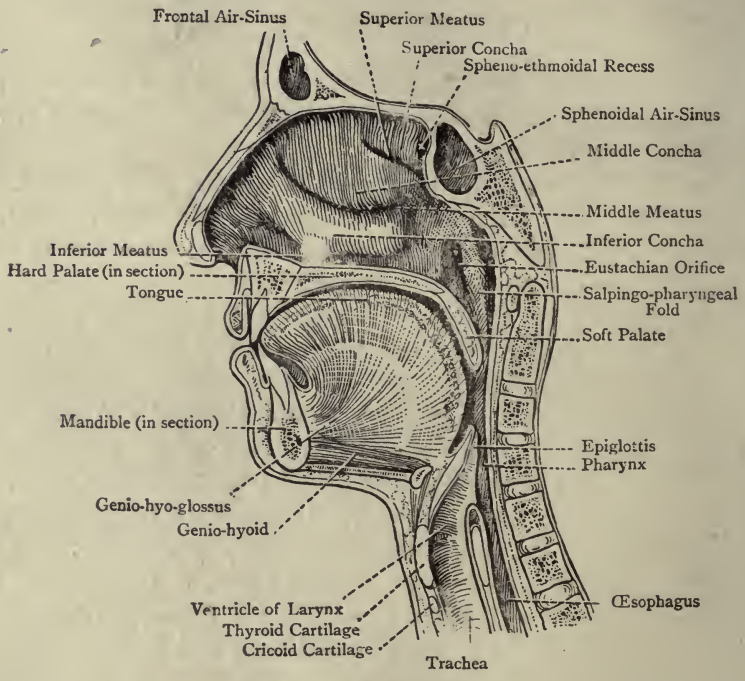


FIG. 51.—THE PHARYNX.

living subject. The thyroid cartilage is joined by a strong membrane to the hyoid bone, and from its inner side the epiglottis, a cartilaginous process, projects upwards to the back of the tongue.

The **Trachea** is the continuation of the air passage; it begins just below the cricoid cartilage at the level of the sixth cervical vertebra and ends at the fourth thoracic vertebra by dividing into two bronchi. The trachea is a muscular tube kept permanently

patent by rings of cartilage, which, however, are not complete posteriorly, so the organ is not quite cylindrical. These cartilaginous rings are continued in the bronchi.

The trachea follows the curve of the vertebral column, so passes obliquely backwards as it descends. It is in the middle line until the bifurcation is reached, where it lies slightly to the right.

The **Bronchi** pass obliquely downwards aud outwards from the bifurcation of the trachea to the roots of the lungs. The

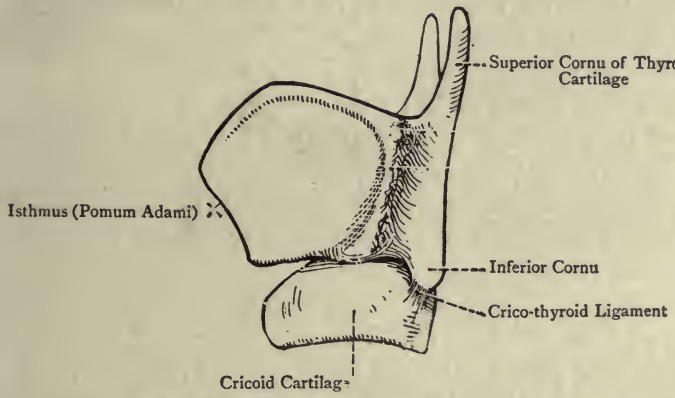


FIG. 52.—THE LARYNGEAL CARTILAGES.

right bronchus is shorter and wider than the left, and is not so obliquely placed. The bronchi have several branches passing to the different lobes of the lungs.

The **Lungs** lie within the pleural cavities of the thorax. A perfectly healthy lung lies quite free within its own pleural sac, attached only by its root; but as a rule adhesions between the lung and pleura are found. The right lung is larger than the left, the proportion being about eleven to ten. It is also shorter and wider.

The lungs take the shape of the pleural cavities, and are conical structures having an apex which projects above the level of the first rib for about half an inch, and a concave base which is adapted to the cupola of the diaphragm, on which it rests. The outer surface is smooth and convex, except for shallow grooves made by the ribs, and the inner surface has the

impressions of the organs against which it lies. The lower border of the outer surface of the lung is thin and reaches down between the diaphragm and the ribs to the level of the lower border of the sixth rib in front; the eighth rib in the mid-axillary line; then passes horizontally inwards, reaching the vertebral column at the level of the tenth rib. The bases of the lungs are in relation with some of the abdominal organs, the diaphragm intervening. Thus, the base of the right lung rests upon the right lobe of the liver, whilst the base of the left lung is in relation with the left lobe of the liver, the fundus of the stomach, and the spleen.

On the anterior and lower part of the inner surface of each lung is a deep recess made by the pericardium (this is deeper in the left than the right), and above the pericardial concavity is the hilum of the lung, where the bronchial vessels and nerves enter, constituting the root of the lung. On the left lung, above and behind the hilum is a broad shallow groove made by the descending thoracic aorta.

The left lung is divided into two lobes by a groove reaching into the hilum; it starts above on the outer surface just below the apex and passes obliquely forwards and downwards to the base near the middle line. The right lobe is divided by a similar line into two, which, however, cuts the base nearer the outer side. The inner and upper lobe is then subdivided by a horizontal line passing inwards and forwards from about the middle of the first line.

The lungs entirely fill the thoracic cavity except for the space in the middle occupied by the trachea, œsophagus, large vessels, heart, and roots of the lungs.

The **Roots of the Lungs** are formed by a number of structures which pass into each lung at the hilum; they consist of the pulmonary veins, the pulmonary artery and the bronchus, nerves, lymphatic vessels and glands.

The **Pleura** is a serous membrane which invests the lungs and lines the thoracic cavity. It is analogous to the peritoneum of the abdomen, and performs the same function—*i.e.*, forms a lubricated covering, so that the organs can move freely in the cavity. The part lining the cavity is called the parietal pleura,

and the part covering the lungs the visceral pleura. The latter is very thin and adherent to the lung, and dips into all the fissures.

The *parietal pleura* is named according to the part over which it passes. The *cervical pleura* rises up to the level of the neck of the first rib. Owing to the oblique position of the latter, the pleura is about an inch and a half above the level of the clavicle; it is strengthened by Sibson's fascia, a strong membrane attached to the seventh cervical vertebra and the inner margin of the first rib. The *costal pleura* lines the inner surfaces of

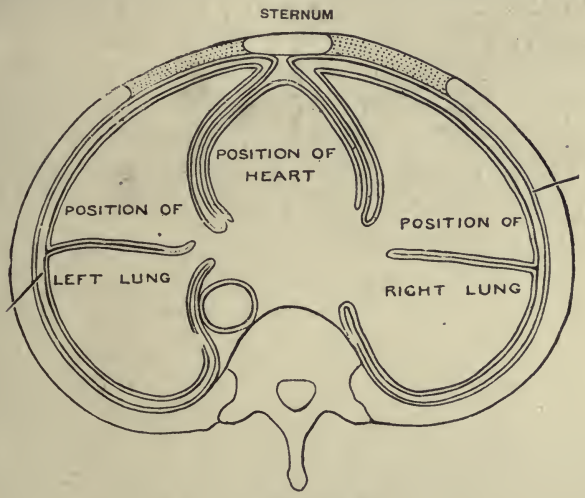


Fig. 53.—The Pleura.

the ribs and the intercostal spaces; it reaches to the sternum in front and the bodies of the vertebræ behind. The *diaphragmatic pleura* covers the surface of the diaphragm except for the middle part, occupied by the pericardium, and a narrow strip at the costal attachment. The *mediastinal pleura* passes back from the sternum to the vertebral column and lines the space (mediastinum) between the lungs. As it passes back it is reflected by the root on to the lung, and becomes the visceral pleura (see Fig. 53). Below the root of the lung the two layers hang down in a deep fold called the ligamentum latum pulmonis.

The parietal pleura is bigger than the lungs require at rest,

and is not quite so big as the entire cavity, the line of reflection being—

Right pleura: Anterior, down the middle line of the sternum to the back of the ensiform cartilage, along the seventh costal cartilage, and across the bony extremities of the eighth and ninth ribs. In the mid-axillary line the pleura reaches its lowest limit—that of the bony tip of the tenth rib. It then ascends slightly, cutting across the eleventh rib to the middle of the twelfth rib and on to the first lumbar vertebra. The posterior line of reflection is to the left of the mid-line of the vertebral bodies, the aorta intervening between them.

Left pleura: This only differs from the right in the anterior line of reflection. Opposite the fourth costal cartilage the left pleura deviates to the left, leaving a small area of pericardium uncovered. It cuts across the fifth, sixth, and seventh costal cartilages to the bony tip of the eighth rib, after which the line of reflection resembles that of the right pleura.

SECTION IX

HEART AND BLOODVESSELS OF HEAD, NECK AND TRUNK

The Heart.

The **Heart** is a four-chambered muscular organ situated in the thorax, in the space between the lungs, and resting on the diaphragm. Its function is to receive the blood from the veins and to propel it through the arteries.

The shape of the heart is that of a cone; it has an apex, a base, and two surfaces (inferior and antero-superior). A shallow groove runs round the heart transverse to its long axis, separating the upper auricular portion from the lower ventricular portion. The division of the upper portion into two auricles is only faintly marked, but a distinct groove divides the lower portion into two ventricles.

The heart is enclosed in a fibro-serous sac—the pericardium—which separates it from the surrounding organs. It rests on the diaphragm, the long axis pointing obliquely downwards, forwards, and to the left. On the surface of the body its position is marked by a quadrilateral area, the boundaries of which are as follows:

Right side—a line slightly convex outwards from the upper end of the third costal cartilage to the sixth, its greatest distance from the middle line being 1½ inches.

Base—from the lowest point on the right side to the fifth intercostal space on the left side, 3½ inches from the middle line. This point marks the position of the apex of the heart.

Left side—a line slightly convex outwards from the left extremity of the base line to the lower border of the second interspace on the left side, 1 inch from the mid-line.

Upper line—a line slightly convex downwards connecting the upper extremities of the right and left sides.

The *Base of the Heart* is formed by the auricles, and is directed upwards, backwards, and to the right. It lies opposite the sixth, seventh, and eighth dorsal vertebræ, separated from them by the œsophagus and descending aorta. It has six orifices—the superior and inferior venæ cavæ entering the

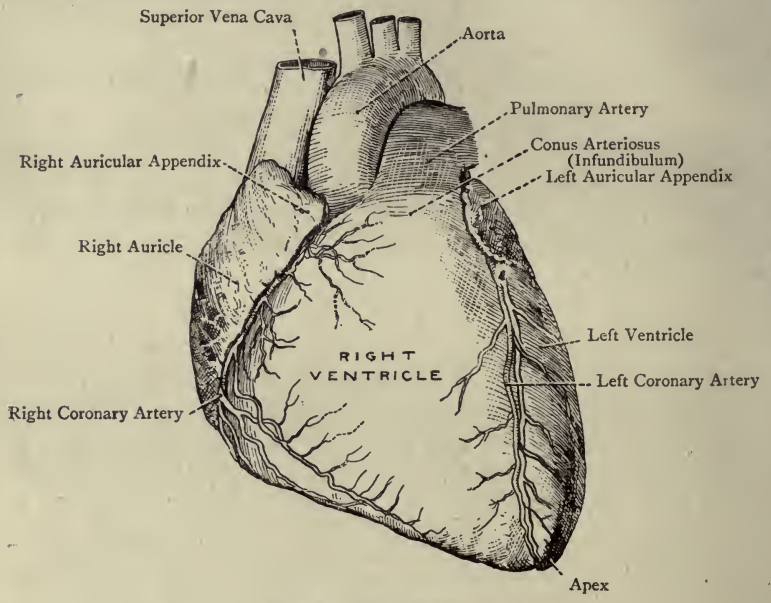


FIG. 54.—THE HEART.

right auricle, and the four pulmonary veins entering the left auricle.

The *Apex of the Heart* is formed entirely by the left ventricle. It is directed downwards, forwards, and to the left, and is separated from the anterior thoracic wall by the left lung and pleura.

The *Inferior Surface* is formed by the ventricular portion of the heart, and rests upon the central tendon of the diaphragm and the muscular part to the left of the tendon.

The *Antero-Superior Surface* is directed backwards, upwards, and to the left. It lies behind the area of the anterior thoracic

wall mapped out above, and is divided into an upper and lower part by the auriculo-ventricular groove. At this point are the orifices of the pulmonary artery and aorta from the right and left ventricles respectively.

The Interior of the Heart.—Internally the heart is completely divided into right and left halves by a septum indicated on the outside by the longitudinal grooves. The transverse septum is not complete, as each auricle communicates with the ventricle below by a valvular opening.

The **Auricles** are almost cubicle in form and each possesses a well-marked process from its upper angle, which projects forwards on the outside of the heart, known as the auricular appendix. The walls are lined with a serous membrane—the endocardium—and are smooth except in the region of the appendix, where there are a few muscular fibres, known as the musculi pectinati. The *right auricle* receives posteriorly the superior vena cava above and the inferior vena cava below, the orifice of the latter being guarded by the rudimentary Eustachian valve. The *left auricle* resembles the right auricle, except that it has four openings in its posterior wall—the orifices of the pulmonary veins.

The **Ventricles** are conical in form and very muscular, the left ventricle being larger and thicker-walled than the right. The longitudinal septum is so placed that the apex of the heart is formed entirely by the left ventricle. The *right ventricle* is continuous with the right auricle, its base giving origin to the pulmonary artery. The right auriculo-ventricular orifice is guarded by the tricuspid valve, and the orifice of the pulmonary artery is also guarded by a valve composed of three cusps. The *left ventricle* is continuous with the left auricle, its base giving origin to the aorta. The left auriculo-ventricular orifice is guarded by the mitral or bicuspid valve, and the orifice of the aorta by the aortic valve composed of three cusps.

The cavities of the ventricles are lined with endocardium, and are smooth except for the muscle fibres, which are more numerous and more pronounced than those of the auricles. Each cavity can be divided into two—the body of the ventricle and the vestibule of the vessel to which it gives origin.

The muscles are of three kinds:

Columnæ Carneæ—bundles of muscle-fibre raised in relief on the walls of the ventricle.

Papillary Muscles—which are attached at each end to the walls of the ventricles, but are free in the middle. These prevent over-distension.

Chordæ Tendineæ—thin bundles of muscle-fibre from the bases of the papillary muscles to the apices of the cusps of the valves.

The **Valves of the Heart** and large vessels are circular orifices with semilunar flaps of muscle (cusps) projecting inwards from the circumference. These meet in the middle and completely close the orifice. A rush of blood pushes these forward, and the cusps automatically close the orifice when the flow ceases. This keeps the blood flowing in one direction and prevents regurgitation.

The **Pericardium** is a fibro-serous sac surrounding the heart. It is attached to the diaphragm all round the inferior surface of the heart, and is prolonged upwards, being gradually lost on the great vessels. The inferior vena cava pierces the pericardium posteriorly.

The Arteries.

The arteries are the bloodvessels which leave the heart and break up into capillaries for the supply of the tissues. There are two systems of circulation—the *pulmonary*, consisting of the pulmonary artery leaving the right ventricle and ending in the pulmonary veins which enter the left auricle; and the *systemic*, consisting of the aorta leaving the left ventricle and ending in the superior and inferior venæ cavæ which enter the right auricle.

The **Pulmonary** artery arises from the base of the right ventricle of the heart. It is a short vessel about 2 inches long. It passes upwards to the left of the ascending aorta, and terminates by dividing into right and left pulmonary arteries, which enter the roots of the right and left lungs respectively.

The **Aorta** rises from the base of the left ventricle of the heart. It passes upwards, backwards, and to the left,

forming an arch, which, on reaching the vertebral column, passes downwards as far as the body of the fourth lumbar vertebra, where it terminates by dividing into the two common

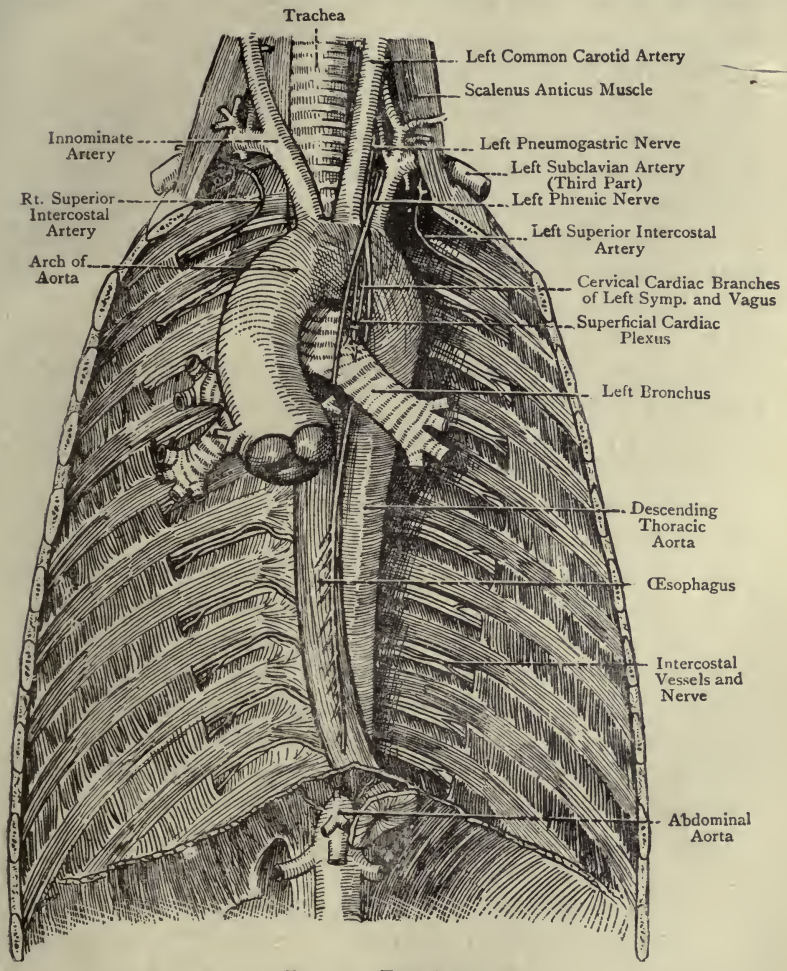


FIG. 55.—THE AORTA.

iliac arteries. For convenience of description it is divided into four parts: (1) The ascending aorta, (2) the arch of the aorta, (3) the descending thoracic aorta, (4) the abdominal aorta.

The *Ascending Aorta* arises from the base of the left ventricle opposite the lower border of the third left costal cartilage. It passes upwards, forwards, and to the right, terminating in the arch of the aorta at the level of the junction of the right second costal cartilage with the sternum.

Branches.—Right and left coronary arteries, which supply the heart muscle.

The *Arch of the Aorta* lies behind the lower part of the manubrium, and begins at the termination of the ascending aorta, terminating as the descending aorta opposite the lower border of the body of the fourth dorsal vertebra. The arch passes upwards, backwards, and to the left in front of the trachea, and curving over the pulmonary artery; it then passes backwards to the left of the trachea and turns downwards.

Branches of the Arch of the Aorta supply the head and neck and upper limb. The branch on the right side—the innominate artery—is a very short trunk, which divides almost at once into right common carotid and right subclavian arteries; the left common carotid and left subclavian arteries are given off from the arch itself.

The *Descending Aorta* extends from the termination of the arch at the fourth dorsal vertebra, and ends at the opening in the diaphragm opposite the twelfth dorsal vertebra, by becoming the abdominal aorta. It lies on the vertebral column and is in contact anteriorly with the root of the left lung, the pericardium, the œsophagus, and the crura of the diaphragm.

The branches are divided into two sets, visceral and parietal, supplying the muscles of the thorax and its contents.

The *Abdominal Aorta* extends from the middle of the body of the last dorsal vertebra to the left side of the body of the fourth lumbar vertebra, where it divides into the two common iliac arteries. The bifurcation is in the intertubercular plane. It lies on the vertebral column, and anteriorly is in contact with the solar plexus, the third part of the duodenum, the mesentery, peritoneum, and coils of small intestine. The pancreas is separated from the aorta by the splenic vein and superior mesenteric artery.

Branches.—The branches are divided into two sets—visceral

and parietal—and each set is again divided into paired and unpaired groups, which supply the viscera, the muscles of the trunk and the lower limbs.

The lumbar arteries which supply the muscles of the trunk arise down the sides of the aorta opposite the bodies of the lumbar vertebræ.

The **Common Carotid** arteries vary slightly at their commencement; otherwise they are similar in course and distribution.

The *Right Common Carotid* artery arises from the innominate artery behind the right sterno-clavicular articulation; the left arises direct from the arch of the aorta about an inch below the left sterno-clavicular articulation. They both terminate at the level of the upper border of the thyroid cartilage of the larynx, or the lower border of the third cervical vertebra. They are separated from one another—below by the trachea and œsophagus, above by the pharynx.

The common carotid artery is enclosed in a fibrous sheath with the vagus nerve and internal jugular vein. It lies on scalenus anticus and longus colli muscles below, and rectus capitis anticus major above, and is covered by sterno-mastoid. On its outer side lies the internal jugular vein, which slightly overlaps it below.

Branches.—The artery bifurcates at its termination, forming the external and internal carotid arteries.

The *External Carotid* artery extends from the bifurcation of the common carotid artery to the back of the neck of the mandible, where it terminates by dividing into the superficial temporal and internal maxillary arteries.

Branches.—Occipital.
Superficial temporal.
Internal maxillary, and five other branches which supply the face, tongue, pharynx, and larynx.

The *Occipital* artery runs upwards under the mastoid process to the back of the scalp, and terminates near the inner end of the superior curved line of the occipital bone. By dividing into branches it supplies the scalp and surrounding structures.

The *Superficial Temporal* artery commences in the parotid

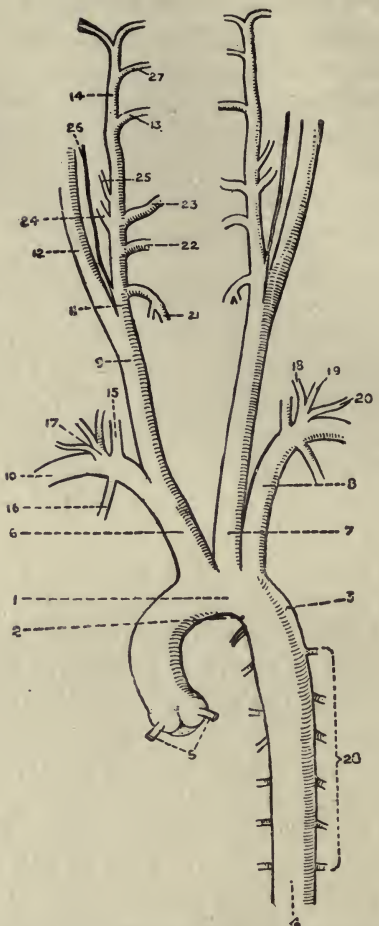


FIG. 56.—THE AORTA IN THE THORAX, AND THE PRINCIPAL ARTERIES OF THE HEAD AND NECK.

1. Arch of the Aorta
2. Aortic Isthmus
3. Aortic Spindle
4. Descending Aorta
5. Coronary Arteries (from Ascending Aorta)
6. Innominate Artery
7. Left Common Carotid
8. Left Subclavian
9. Right Common Carotid
10. Right Subclavian
11. External Carotid
12. Internal Carotid
13. Internal Maxillary
14. Superficial Temporal
15. Vertebral
16. Internal Mammary
17. Thyroid Axis
18. Inferior Thyroid
19. Transverse Cervical
20. Suprascapular
21. Superior Thyroid
22. Lingual
23. Facial
24. Occipital
25. Posterior Auricular
26. Ascending Pharyngeal
27. Transverse Facial
28. Aortic Intercostals

gland and runs straight up, terminating about 2 inches above the zygoma by dividing into branches. It supplies the scalp and surrounding structures.

The *Internal Maxillary* artery commences in the parotid gland and passes inwards to supply the teeth and structures behind the superior maxilla and mandible.

The *Internal Carotid* artery commences at the bifurcation of the common carotid and terminates in the brain by dividing into branches. At first it lies on the outer side of the external carotid, but passes behind it and gets to the inner side. It passes up at the back of the parotid gland and reaches the brain by means of the carotid canal in the temporal bone.

The **Subclavian** arteries also vary slightly at their commencement, the right subclavian artery commencing at the bifurcation of the innominate artery behind the right sterno-clavicular articulation, and the left subclavian artery commencing from the arch of the aorta behind the lower part of the manubrium sterni. The artery arches up over the apex of the lung, and passing between scalenus anticus and medius, it ends at the lower border of the first rib by becoming the axillary artery. The scalenus anticus, in crossing the subclavian artery divides it into three parts—the first part being internal to the muscle, the second behind it, and the third on the external side. The third part of the artery is separated from scalenus medius by the cords of the brachial plexus.

Branches.—From the first part:

Vertebral, thyroid axis, internal mammary.

From the second part: Superior intercostal.

The *Vertebral* artery arises from the subclavian artery just between scalenus anticus and longus colli. It passes backwards and upwards through the foramina in the transverse processes of the cervical vertebræ, and entering the foramen magnum, terminates by uniting with its fellow of the opposite side to form the basilar artery. The basilar artery divides again, and the branches are united by the posterior communicating arteries to the internal carotid arteries to form the Circle of Willis for the free supply of the brain.

The *Thyroid Axis* is a very short trunk, which ends by dividing into three—the inferior thyroid, transverse cervical, and suprascapular—which supply the shoulder and adjacent parts.

The *Internal Mammary* artery passes down on the pleura supplying the adjacent parts—the diaphragm and the upper part of the anterior abdominal wall.

The *Superior Intercostal* artery passes backwards over the pleura to the neck of the first rib. There it divides into two branches for the supply of the upper two intercostal spaces.

The **Branches of the Thoracic Aorta** are divided into two groups—visceral and parietal. The visceral branches supply the bronchi, œsophagus, and pericardium, and several small branches to structures in the vicinity. The parietal supply the intercostal muscles and the upper surface of the diaphragm.

The *Intercostal* arteries, of which there are nine pairs, supply the nine lower intercostal spaces. Each artery passes backwards behind the pleura and runs in the groove at the lower border of each rib. The *Subcostal* pair of arteries are in series with this, and run in the groove on the twelfth rib.

The **Branches of the Abdominal Aorta** are in two groups —visceral and parietal. The visceral branches supply the abdominal organs, the parietal branches supply the abdominal walls.

Visceral.		Parietal.	
Paired.	Unpaired.	Paired.	Unpaired.
Suprarenal Renal Spermatic *or* Ovarian	Cœliac axis Superior mesenteric Inferior mesenteric	Inferior phrenic Lumbar (four pairs) Common iliac	Middle sacral

The order in which the branches arise from the abdominal aorta is as follows:

1. Inferior phrenic.
2. Cœliac axis.
3. Middle suprarenal.
4. Superior mesenteric.
5. Renal.
6. Spermatic or ovarian.
7. Inferior mesenteric.
8. Middle sacral.
9. Common iliac.

The **Paired Parietal Branches.**—The *Inferior Phrenic* arteries are the first branches which curve off the aorta as it enters the abdomen. They supply the under surface of the diaphragm.

The *Lumbar* arteries, of which there are usually four pairs, arise in series with the intercostal arteries. They pass back-

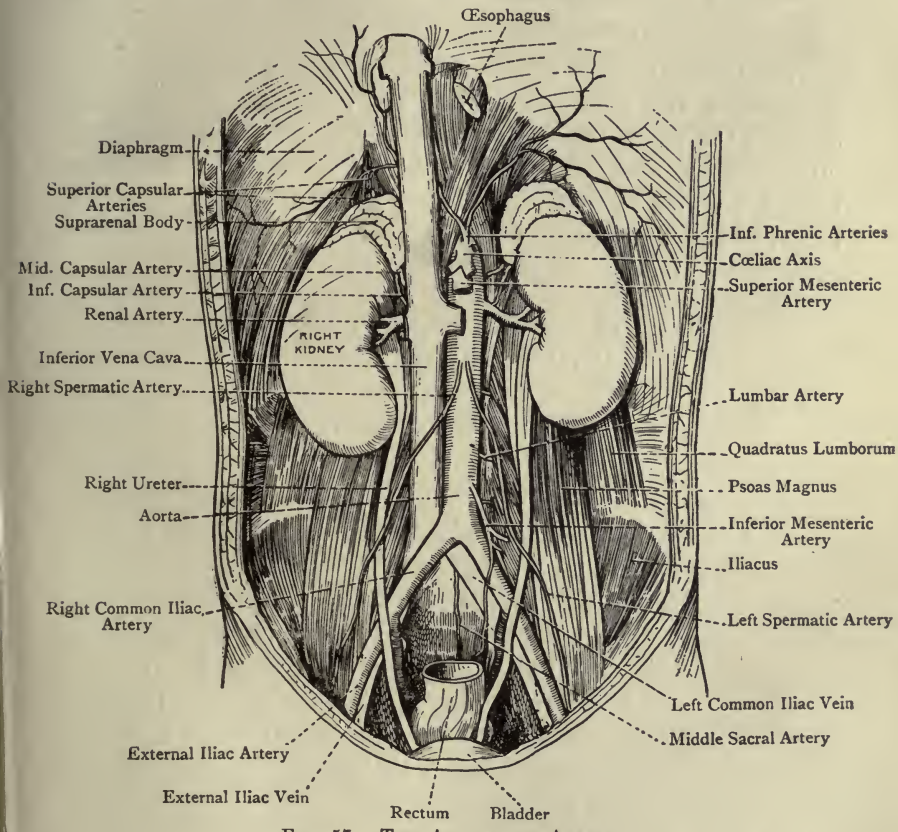


FIG. 57.—THE ABDOMINAL AORTA.

wards over the bodies of the lumbar vertebræ and between the adjacent transverse processes. They pass behind psoas and cross quadratus lumborum to get between the muscles of the anterior abdominal wall.

The *Common Iliac* arteries are formed by the bifurcation of the aorta at the lower border of the fourth lumbar vertebra.

They terminate opposite the lumbo-sacral joint by dividing into external and internal iliac. The common iliac arteries lie on the bodies of the fourth and fifth lumbar vertebræ and on psoas, and are separated anteriorly and externally from the coils of the small intestine by the peritoneum.

Branches.—Internal iliac.
External iliac.

The *Internal Iliac* artery arises opposite the lumbo-sacral articulation and passes down into the true pelvis, terminating opposite the upper border of the great sciatic notch by dividing into anterior and posterior divisions, giving off numerous branches which supply the pelvic wall and viscera, buttock, thigh, and external genital organs.

Posterior division—

Parietal: Ilio-lumbar } supply the muscles of the iliac
Lateral-sacral } fossa and front of sacrum.
Gluteal, passes out above pyriformis to supply the gluteal muscles.

Anterior division—

Visceral: supply the bladder and internal genital organs.
Parietal: Obturator, supplies the obturator muscles.
Sciatic, passes out below pyriformis and supplies the muscles on the upper part of the thigh.
Internal pudic—passes out below pyriformis, and, crossing the ischial spine with the pudic nerve, it enters and supplies the perineum.

The *External Iliac* artery arises opposite the sacro-iliac joint, and, passing outwards and forwards along the brim of the pelvis, it passes under the mid-point of Poupart's ligament and becomes the femoral artery. It lies on psoas and iliacus, and is separated from the colon and small intestine by the peritoneum.

Branches.—Deep epigastric and deep circumflex iliac supply the muscles and skin of the anterior abdominal wall.

The Unpaired Parietal Branch.—The *Middle Sacral* artery is a small artery arising from the back of the aorta just before its bifurcation. It passes down the middle of the sacrum, supplying the muscles and joints in the vicinity.

The Paired Visceral Branches.—The *Suprarenal* arteries consist of three pairs of arteries for the supply of the suprarenal capsule. The middle pair arises from the aorta direct, the others are branches of adjacent arteries.

The *Renal* arteries arise opposite the second lumbar vertebra just below the superior mesenteric. Each passes transversely outwards over the crus of the diaphragm and the upper part of psoas to the hilum of the kidney. The right artery is a little longer than the left and often lower in position. It passes behind the inferior vena cava, the head of the pancreas, and the middle of the duodenum. The left artery lies behind the pancreas.

The *Spermatic* or *Ovarian* arteries arise just below the renal arteries. The spermatic arteries run downward and outwards through the inguinal canal to supply the testicles. The ovarian arteries are much shorter, and pass straight down into the pelvis and supply the ovaries.

The Unpaired Visceral Branches.—The *Cœliac Axis* arises from the front of the aorta just after it has entered the abdomen. It is very short (about half an inch), and divides almost at once into three branches:

1. Gastric.
2. Splenic.
3. Hepatic.

The *Gastric* artery runs upwards and to the left to the œsophagus, and passes along the smaller curvature of the stomach between the layers of the small omentum to join the pyloric branch of the hepatic artery.

The *Splenic* artery runs behind the stomach along the upper border of the pancreas. It passes between the two layers of the lieno-renal ligament and enters the hilum of the spleen.

The *Hepatic* artery runs along the head of the pancreas to the first part of the duodenum. It then passes upwards to the

transverse fissure of the liver and divides into right and left branches. It gives off two branches—the *pyloric*, which goes to the pylorus and supplies both sides of the stomach; the *gastro-duodenal*, whose terminal branches supply the larger curvature of the stomach, the head of the pancreas, and the duodenum.

FIG. 58.—THE INFERIOR MESENTERIC ARTERY AND ITS BRANCHES (AFTER TIEDEMANN).

1. Superior Mesenteric Artery
2. Middle Colic
3. Inferior Mesenteric
4. Left Colic
5. Arteriæ Sigmoideæ
6. Superior Hemorrhoidal
7. Transverse Colon
8. Descending Colon
9. Iliac Colon
10. Pelvic Colon

The *Superior Mesenteric* artery arises half an inch below the cœliac and opposite the first lumbar vertebra. It crosses obliquely downwards over the head of the pancreas to the root of the mesentery. It gives off numerous branches which supply

the duodenum, small intestine, and ascending and transverse colons.

The *Inferior Mesenteric* artery arises a short distance above the bifurcation of the aorta. It passes downwards over the left psoas and becomes the superior hæmorrhoidal. It supplies the descending colon and the rectum.

The Veins.

The veins are formed by the aggregation of the capillaries, and return the blood to the heart. They, like the arteries, are arranged in two sets—*pulmonary* and *systemic*. The pulmonary veins enter the left auricle of the heart by four openings, and the systemic veins—*i.e.*, the coronary sinus, and superior and inferior venæ cavæ—enter the right auricle by three openings.

The **Pulmonary** veins are found in the alveoli of the lungs, and form a single large vessel for each lobe. In the root of the right lung the veins from the upper and middle lobes join together, so that two veins pass out from the root of each lung to enter the left auricle.

Systemic Veins.—The systemic veins, three in number, all enter the right auricle.

The *coronary sinus* returns the blood from the walls of the heart only. The *superior vena cava* returns the blood from the head, neck, upper limbs, thoracic wall, and a part of the posterior abdominal wall. The *inferior vena cava* returns blood from the lower limbs, and the walls and organs of the abdomen and pelvis.

The veins of the body wall and limbs are arranged in two sets—superficial and deep. The *superficial* veins run in the superficial fascia, and the *deep* veins accompany the arteries, usually as venæ comites. The superficial veins ultimately pierce the deep fascia to unite with the deep veins. The visceral veins, of which there is usually one accompanying the artery, end in the deep systemic veins, with the exception of the portal vein.

The **Coronary Sinus** lies between the left auricle and left ventricle, and terminates in the lower and back part of the

right auricle. It receives the blood from the walls of the heart.

The **Superior Vena Cava** is formed at the lower border of the first right costal cartilage by the junction of the two innominate veins, descends to the level of the third right costal cartilage, where it enters the right auricle. Anteriorly it is overlapped by the right lung and pleura and the ascending aorta.

Tributaries.—Vena azygos major.
Small pericardial veins.

The *Vena azygos major* is the upward continuation of a vessel known as the right ascending lumbar vein, which connects together the lumbar veins of the right side. It passes through the aortic opening in the diaphragm, up the posterior thoracic wall, and arches over the root of the right lung to enter the superior vena cava. It receives the right intercostal veins and the vena azygos minor superior and inferior, which receive the lumbar and intercostal veins of the left side.

The **Innominate Vein** of each side is formed behind the sternal end of the clavicle by the union of the internal jugular with the subclavian vein. The two innominate veins unite to form the superior vena cava behind the first right costal cartilage; consequently the left one is longer than the right.

The tributaries are the veins corresponding to the arteries in that region—viz., internal mammary, inferior thyroid, vertebral, pericardial, and bronchial.

The **Internal Jugular** vein commences as the direct continuation of the lateral sinus of the brain, and passes through the jugular foramen to reach the neck, uniting behind the sternal nd of the clavicle with the subclavian vein to form the innominate vein. It lies on the outer side of the common carotid artery, and on the left side overlaps it in front at its lower end.

Tributaries.—Sinus in the brain.
Veins from the wall of the pharynx, the tongue, and the veins accompanying the thyroid arteries.

Common facial, formed by union of facial and a terminal branch of the temporo-maxillary veins, which drain the muscles of the face and fore-part of the scalp.

Occipital vein, which drains the back part of the scalp.

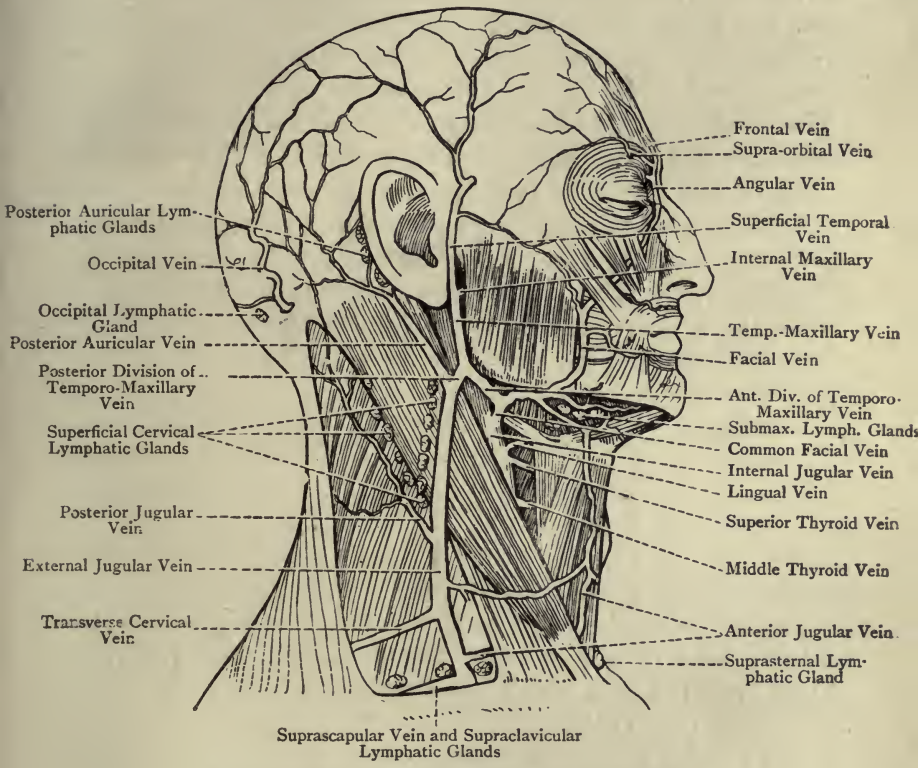


FIG. 59.—VEINS AND GLANDS OF HEAD AND NECK.

The **Subclavian** vein is the direct continuation of the axillary vein. It commences at the lower border of the first rib and passes in front of scalenus anticus, which separates it from the artery, and terminates behind the sternal end of the clavicle by uniting with the internal jugular vein to form the innominate vein.

Tributary.—External jugular formed on the surface of the sterno-mastoid by the union of the terminal branch of the temporo-maxillary with the posterior auricular vein, which drain the outer side of the head and neck.

The **Inferior Vena Cava** is formed opposite the right side of the body of the fifth lumbar vertebra behind and external to the right common iliac artery by the union of the common iliac veins. It passes up the posterior wall of the abdomen to the right of the aorta and on the right crus of the diaphragm, and passes through the latter at the level of the eighth dorsal vertebra. It then pierces the pericardium and enters the lower and back part of the right auricle. The vessel lies below on the bodies of the lumbar vertebræ, the right psoas, and the right crus of the diaphragm, the right renal artery, and suprarenal capsule. Anterior to it are the right common iliac artery, the third part of the duodenum, head of the pancreas, the portal vein, the first part of the duodenum, and the posterior surface of the liver. On its left side are the aorta and the left crus of the diaphragm.

Tributaries.—Hepatic.
Inferior phrenic.
Suprarenal.
Renal.
Lumbar.
Spermatic or ovarian.

The *Hepatic* veins are two in number, which open into the inferior vena cava just below the diaphragm, and bring the blood from the liver which has entered it through the hepatic artery and portal vein.

The *Inferior Phrenic* veins are formed by the venæ comites of the arteries supplying the diaphragm.

The *Suprarenal* veins are one each from the suprarenal capsules. Sometimes the one on the left side enters the left renal vein.

The *Renal* veins each issue from the hilum of the kidney, the left one being longer than the right. The left one crosses in front of the left psoas, the left crus of the diaphragm, and the aorta just below the superior mesenteric artery, and lies

behind the pancreas and the last part of the duodenum. The right renal vein passes behind the duodenum.

The *Lumbar* veins, of which there are four pairs, are formed by tributaries from the lateral and posterior walls of the abdomen. They are also connected together by the azygos veins, anastomosing vessels passing upwards.

The *Spermatic* or *Ovarian* veins are formed by the pampiniform plexuses surrounding the testicles or ovaries. The vein on the right side enters the inferior vena cava, that on the left usually enters the left renal vein.

The **Common Iliac** veins are formed by the union of the external iliac and internal iliac veins opposite the brim of the pelvis behind the internal iliac artery. They pass upwards and inwards, and unite to form the inferior vena cava opposite the fifth lumbar vertebra.

Tributaries.—External iliac.
Internal iliac.
Ilio-lumbar, small veins from the iliac fossa and adjacent parts.

The *Internal Iliac* vein is formed at the upper border of the great sciatic notch by the union of veins correspondiug to the branches of the internal iliac artery, except the ilio-lumbar branches. It lies behind and slightly to the inner side of the corresponding artery.

The *External Iliac* vein is the continuation of the femoral vein, and commences on the inner side of the femoral artery. Passing upwards and inwards along the brim of the pelvis, it ends by joining the internal iliac to form the common iliac vein.

The Portal System.—The portal vein is formed by tributaries from the whole of the alimentary canal (except the lower part of the rectum), the spleen and the pancreas, and conveys the blood thus collected to the liver. The tributary veins correspond at first with the arteries supplying these organs, but the terminal veins differ somewhat. The inferior mesenteric vein joins the splenic vein, and they join with the superior mesentric vein to form the portal vein. The portal vein is a short wide vessel about three inches long, which commences behind the

neck of the pancreas in front of the left border of the inferior vena cava. It passes upwards behind the pancreas, duodenum, and common bile-duct, and enters the transverse fissure of the liver.

The **Middle and Inferior Hæmorrhoidal** veins which drain the lower part of the rectum, enter the internal iliac vein, and thus connect the vena cava and portal systems.

SECTION X

THE BLOODVESSELS OF THE UPPER LIMB

Arteries of the Upper Limb.

The blood-supply of the upper limb is derived from the continuation of the subclavian artery, which at the lower border of the first rib changes its name and becomes the axillary artery.

Axillary Artery.—From the lower border of the first rib to the lower border of the teres major.

The axillary artery passes through the axillary space, and lies on, successively, upper digitation of serratus magnus, subscapularis, latissimus dorsi, teres major, and is covered by pectoralis major and minor.

The pectoralis minor muscle crosses the middle third of the artery and divides it into three parts.

The three cords of the brachial plexus lie respectively to the inner, outer, and posterior sides of the artery.

The axillary vein lies along the inner side of the artery.

Branches.—From first and second parts:

Several thoracic branches to supply the neighbouring parts.

From third part:

1. *Subscapular,* which arises opposite the lower border of the scapularis and supplies the adjacent muscles and inner wall of axillary space.

2. *Anterior and Posterior Circumflex,* which enclose the surgical neck of the humerus and supply the shoulder-joint and adjacent muscles (see Fig. 6).

The axillary artery is continued as the *brachial* artery, which passes down to supply the upper arm.

Brachial Artery.—From the lower border of teres major to the antecubital fossa, where, at the level of the neck of the

radius, it terminates by dividing into the radial and ulnar arteries.

The brachial artery passes downwards and outwards, and lies on, successively, long head of triceps, insertion of coraco-brachialis, brachialis anticus, and is covered by the inner border of biceps.

In its upper half the median and ulnar nerves lie respectively on the external and internal sides of the artery, and at the middle the median nerve crosses over to the inner side of the artery, while the ulnar nerve passes to the back of the arm.

Branches.—1. *Superior Profunda,* runs downwards and backwards with the musculo-spiral nerve to the back of the arm.

2. *Inferior Profunda,* runs downwards and backwards with the ulnar nerve to the back of the elbow-joint.

3. *Anastomotic* pierces the internal intermuscular septum and passes also to the back of the elbow-joint.

4. Small muscular branches are given off to the adjacent muscles.

Radial Artery.—The radial artery is the smaller of the two terminal branches of the brachial artery, but the more direct continuation of the parent trunk. It passes down the outer side of the forearm, and at the wrist winds round the trapezium to reach the back of the hand; it then comes back through the first interosseous space, and anastomoses with the deep branch of the ulnar artery to form the deep palmar arch.

It lies successively on insertion of biceps, supinator brevis, pronator radii teres, radial head of flexor sublimis digitorum, flexor longus pollicis, pronator quadratus, anterior ligament of wrist-joint.

It is covered by inner border of supinator longus (brachio-radialis) in its upper two-thirds. The lower third is subcutaneous.

The radial nerve is in relation to the artery in its middle third, and lies on its outer side.

Branches.—1. *Superficial Volar,* which arises just above the wrist, and, passing down over the ball of the thumb, anastomoses with the superficial branch of the ulnar artery to form the superficial palmar arch.

2. *Anterior Carpal,* given off at the wrist and anastomoses with a similar branch of the ulnar artery.

3. *Posterior Carpal,* a small branch which passes backwards and anastomoses with a similar branch from the ulnar artery to form the posterior carpal arch.

4. Muscular branches for the supply of the adjacent muscles.

Ulnar Artery.—The larger of the two terminal branches of the brachial artery arises in the antecubital fossa, and terminates in the palm of the hand by forming the palmar arches.

It lies successively on brachialis anticus, flexor profundus digitorum, pronator quadratus, anterior annular ligament.

It is covered by the (pronator radii teres, flexor sublimis digitorum, flexor carpi radialis, palmaris longus, flexor carpi ulnaris) superficial group of flexor muscles from internal condyle of humerus, and in its lower third is subcutaneous.

The median nerve crosses it above, being separated from the artery by the deep head of pronator radii teres, and on its inner side lies the ulnar nerve.

Branches.—1. *Common Interosseous,* a very short trunk arising in the antecubital fossa, and dividing into the anterior and posterior interosseous arteries.

(*a*) The *Anterior Interosseous* artery runs down on the anterior surface of the interosseous membrane to the upper border of pronator quadratus, where it pierces the membrane and terminates in the posterior carpal arch.

(*b*) The *Posterior Interosseous* artery passes down the back of the forearm between the superficial and deep muscles which it supplies, and ends by anastomosing with the anterior interosseous artery and the posterior carpal arch.

2. *Anterior Carpal,* a small branch given off just above the wrist, which anastomoses with a similar branch from the radial artery to form the anterior carpal arch.

3. *Posterior Carpal,* a small branch which passes backwards and anastomoses with a similar branch from the radial artery to form the posterior carpal arch.

The ulnar artery crosses over the annular ligament, and terminates in the palm of the hand by dividing into superficial and deep branches.

The **Superficial Palmar Arch** is formed at the level of the distal border of the abducted thumb by the anastomosis of the superficial volar branch of the radial artery with the superficial terminal branch of the ulnar artery.

It lies on flexor brevis minimi digiti, opponens minimi digiti, and tendons of flexor sublimis digitorum. It is covered by palmar fascia and integument.

The **Deep Palmar Arch** is formed about three-quarters of an inch above the level of the superficial arch, by the anastomosis of the radial artery with the deep terminal branch of the ulnar artery.

It lies deeply in the palm on the bases of the metacarpal bones and the interossei muscles, and is covered by the flexor tendons. From the arches branches are given off for the supply of the muscles and fingers.

The back of the hand and fingers are supplied by branches given off from the radial artery while it lies on the back of the trapezium.

Veins of the Upper Limb.

The veins of the upper limb are arranged in two sets—superficial and deep. Both sets open eventually into a common trunk, known as the axillary vein, which continues as the subclavian vein to the innominate vein.

The **Deep** veins consist of venæ comites arranged in the usual way, which open into the axillary vein.

The **Axillary** vein commences as the continuation of the basilic vein opposite the lower border of teres major, and terminates at the lower border of the first rib by becoming the subclavian vein. Its muscular relations are similar to those of the axillary artery, from which it is separated in the lower part of its course by the ulnar nerve, and above by the inner cord of the brachial plexus. To the inner side of the axillary vein lie the groups of axillary glands.

Tributaries.—1. *Venæ Comites* of the brachial artery at the lower border of the subscapularis muscle.

2. *Cephalic* vein at the upper border of pectoralis minor.

3. *Tributaries* corresponding to the branches of the axillary artery.

The **Superficial** veins commence in the superficial fascia of the palm and dorsum of the hand, and of the fingers.

The superficial veins of the palm and palmar surface of the fingers are relatively small, and after forming a small irregular plexus end in the median and anterior ulnar veins of the forearm.

On the dorsal aspect of the fingers are the dorso-lateral veins, which ascend along the dorso-lateral borders of each digit. They receive tributaries from all the tissues of the fingers, and terminate in a dorsal venous plexus, or arch, which lies at the level of the bases of the four inner metacarpal bones. The arch finally terminates in the radial and posterior ulnar veins of the forearm.

There are four superficial veins in the forearm:

1. The **Median** vein which commences on the dorsal aspect of the base of the thumb. It turns round the radial border of the wrist, and, passing up the middle of the forearm, terminates by dividing into the median cephalic and median basilic veins.

Tributaries.—(1) *Deep Median* vein, a short vessel which connects the deep and superficial veins at the elbow-joint.

(2) *Tributaries* from the adjacent tissues.

2. The **Radial** vein commences in the dorsal venous plexus of the hand and runs up the outer border of the forearm, receiving tributaries from the adjacent tissues. It ends at the outer side of the elbow by joining the median cephalic vein to form the cephalic vein.

3. The **Anterior Ulnar** vein commences at the base of the little finger, and, passing up the ulnar side of the anterior surface of the forearm, ends in the basilic vein.

4. The **Posterior Ulnar** vein (usually considerably larger than the anterior) commences in the dorsal venous plexus, and ascends along the dorsal side of the ulnar aspect of the forearm. It terminates by joining the median basilic vein to form the basilic vein.

The median cephalic and median basilic veins are formed by the division of the median vein; they are both short vessels.

The median cephalic vein passes upwards and outwards, and opposite the external condyle of the humerus joins the radial vein to form the cephalic vein. The median basilic vein similarly forms the basilic vein opposite the internal condyle by joining with the anterior and posterior ulnar veins.

The upper arm contains only two large veins.

1. The **Basilic** vein commences opposite the inner side of the bend of the elbow, and passing upwards on the inner side of biceps to the middle of the arm it pierces the deep fascia, and opposite the lower border of teres major becomes the axillary vein.

2. The **Cephalic** vein commences at the outer side of the bend of the elbow and ascends on the outer side of biceps. It then pierces the deep fascia, and passing between the adjacent borders of the deltoid and pectoralis major muscles, it pierces the costo-coracoid membrane and enters the third part of the axillary vein.

SECTION XI

THE BLOODVESSELS OF THE LOWER LIMB

Arteries of the Lower Limb.

The blood-supply of the lower limb is derived from the continuation of the external iliac artery, which, passing under Poupart's ligament, changes its name and becomes the femoral artery, which passes from the lower border of Poupart's ligament to the opening in the insertion of adductor magnus.

The **Femoral** artery passes through Scarpa's triangle, then enters Hunter's canal.

Scarpa's triangle is a muscular space situated in the upper anterior portion of the thigh: it is triangular with the apex downwards; the base is formed by Poupart's ligament, the outer side by sartorius, the inner side by adductor longus; in the floor are seen ilio-psoas, pectineus and adductor brevis; the contents are femoral artery and vein, anterior crural nerve, and lymph glands.

In *Scarpa's triangle* it lies on, successively, posterior part of femoral sheath, pubic portion of fascia lata, psoas, pectineus, adductor longus (upper part), and is covered by skin and fascia, superficial glands and vessels. On the outer side of the artery above lies the anterior crural nerve, and lower down the internal saphenous nerve.

The femoral vein lies behind the artery in the lower part of Scarpa's triangle, passes to its inner side above, and is separated from the artery by the outer septum of the femoral sheath.

Hunter's canal is a potential space between the adductor muscles and vastus internus, covered by sartorius; the contents are the femoral artery and vein, and long saphenous nerve.

In *Hunter's canal* the artery lies on, successively, adductor

longus, adductor magnus, and is covered by sartorius, and on the outer side lies vastus internus.

The long saphenous nerve enters the canal with the artery, and crossing over passes out on its inner side.

The femoral vein lies behind the artery on its outer side below and on its inner side above.

Branches (in Scarpa's triangle):

(1) Superficial external pudic,
(2) Superficial epigastric,
(3) Superficial circumflex iliac,

all of which supply the lower part of the abdominal wall and superficially the external genital organs.

(4) Muscular,
(5) Deep external pudic,
(6) Profunda,

all of which supply the muscles on the front and inner side of the thigh, the profunda sending off a number of perforating branches, which curve backwards and outwards round the femur.

In Hunter's canal (near the lower end):

(7) Anastomotica magna, which anastomoses with the terminations of the other branches and the articular branches of the popliteal artery.

The femoral artery is continued as the popliteal artery, which lies in the popliteal space at the back of the knee-joint.

The *Popliteal Space* is a diamond-shaped space at the back of the knee, covered in by a very strong fascia; above, the boundaries are the ham-strings, biceps on the outer side, semitendinosus and semimembranosus on the inner side; below, the two heads of the gastrocnemius; the floor is formed by the posterior surface of the femur, and popliteus. The contents are the popliteal artery and vein, the popliteal nerves and lymphatic glands.

Popliteal Artery.—From the opening in the insertion of adductor magnus to the lower border of popliteus, where it terminates by dividing into the anterior and posterior tibial arteries.

The artery descends with an outward inclination to the space between the condyles of the femur, and then continues vertically downwards. It is in contact in front with the popliteal surface

of the femur, posterior ligament of knee-joint, posterior surface of popliteus, and is covered by outer border of semimembranosus, and adjacent borders of heads of gastrocnemius. On its outer side above lies the internal popliteal nerve, which crosses its middle and lies on its inner side below.

The *Popliteal Vein* lies behind the artery below, then crosses its middle, lying between it and the internal popliteal nerve, and passes upwards on its outer side.

Branches.—*Muscular* to the adjacent parts.

Articular to the knee-joint (five in number).

Posterior Tibial Artery.—The larger of the two terminal branches of the popliteal artery commences at the lower border of popliteus and terminates at the lower border of the internal annular ligament midway between the tip of the internal malleolus and the os calcis. It ends by dividing into the internal and external plantar arteries. The artery lies between the deep and superficial groups of muscles on the back of the leg, and is in contact in front from above downwards with tibialis posticus, flexor longus digitorum, posterior surface of tibia, posterior ligament of ankle-joint. It is covered by, successively, gastrocnemius, soleus, skin and fascia, internal annular ligament, origin of abductor hallucis.

The internal popliteal nerve lies above on the inner side of the artery, and crosses it about an inch and a half below its origin, and is continued down its outer side.

The artery is accompanied by venæ comites, one on each side.

Beneath the internal annular ligament the tendons of tibialis posticus and flexor longus digitorum lie in the front of the artery and that of flexor longus hallucis behind it.

Branches.—1. *Muscular* to soleus and the deep muscles.

2. *Cutaneous* to skin of back of leg.

3. *Internal Malleolar* to the inner surface of the internal malleolus, which anastomoses with a similar branch of the anterior tibial artery.

4. *Peroneal,* the largest branch of the posterior tibial artery, arises about an inch below the lower border of popliteus, and, curving outwards, supplies the peroneal muscles.

Internal Plantar Artery.—The smaller of the two terminal branches of the posterior tibial artery passes forwards along the inner side of the foot between abductor hallucis and flexor brevis digitorum to the head of the first metatarsal bone, where it unites with a branch of the dorsalis pedis artery, the termination of the anterior tibial artery.

External Plantar Artery.—The larger of the two terminal branches runs outwards and forwards between flexor brevis digitorum on the inner side and accessorius and abductor minimi digiti on the outer side to the base of the fifth metatarsal bone. It then passes inwards across the bases of the metatarsal bones, where on the outer side of the first one it terminates by anastomosing with the dorsalis pedis artery, thus forming the plantar arch (see Fig. 24).

Branches.—1. Internal calcaneal.

2. Muscular.

3. Cutaneous.

From the arch—

4. Digital branches—four in number—running on the outer side of the little toe and the plantar surfaces of the interosseous muscles.

5. Perforating arteries—three in number—anastomosing with the dorsal arteries.

6. Articular to the tarsal joints.

Anterior Tibial Artery.—The smaller of the two terminal branches of the popliteal artery passes forward above the interosseous membrane and runs down the front of the leg and terminates by becoming the dorsal artery of the foot from the lower border of popliteus to the front of the ankle. It lies on, successively, anterior surface upper two-thirds of interosseous membrane, shaft of tibia, anterior ligament of ankle-joint.

On the inner side of the upper two-thirds lies the tibialis anticus, and in the lower third the extensor longus hallucis crosses over and lies on the inner side. On the outer side of the upper two-thirds lie respectively extensor longus digitorum and extensor longus hallucis, and the last part of the artery lies between the tendons of these two muscles.

The anterior tibial nerve lies on the outer side of the artery,

and at the ankle lies between it and the outermost tendon of extensor longus digitorum. The artery is accompanied by venæ comites.

Branches.—1. Muscular to adjacent parts.
2. Cutaneous to skin of front of leg.
3. Internal malleolar anastomoses with posterior tibial.
4. External malleolar anastomoses with peroneal.

Dorsalis Pedis artery is the direct continuation of the anterior tibial artery from the front of the ankle-joint to the posterior extremity of the first interosseous space, where it anastomoses with the external plantar artery to form the plantar arch. It lies on, successively, anterior ligament of the ankle-joint, head of the astragalus, navicular bone, intercuneiform ligaments.

It is covered by skin and fascia and the lower part of the anterior annular ligament.

The internal terminal branch of the anterior tibial nerve lies on the outer side of the artery, between it and the extensor brevis digitorum.

The tendon of extensor proprius hallucis lies on the inner side.

Branches.—1. Cutaneous to skin of dorsum of foot.

2. Dorsalis hallucis runs on first interosseus muscle and supplies first and second toes.

3. Metatarsal arises just before termination of artery, and, running outwards, gives off branches to supply the digital clefts.

Veins of the Lower Limb.

The veins of the lower limb are arranged in a similar manner to those of the upper limb, in two groups—superficial and deep.

The **Deep** veins consist of venæ comites accompanying all the arteries in the leg, which unite to form the **Popliteal** vein at the lower border of popliteus. The popliteal vein passes upwards through the popliteal space, at first on the inner side of the artery and above on the outer side; it then passes through the opening in adductor magnus and becomes the femoral vein.

The **Femoral** vein is the direct continuation of the popliteal vein. It ascends through Hunter's canal and Scarpa's triangle,

and, passing under Poupart's ligament on the inner side of the femoral artery, becomes the external iliac vein.

The **Superficial** veins of the lower limb are two in number —the *internal* or *long saphenous* vein and the *external* or *short saphenous* vein.

The veins on the toes are arranged similarly to those of the fingers, and form plexuses on the sole and dorsum of the foot, which enter the external and internal saphenous veins respectively.

The **Internal Saphenous** vein is formed by the veins on the inner side of the sole and dorsum of the foot. It passes upwards in front of the internal malleolus, and, passing behind the inner border of the tibia, it runs up the leg to a point behind the internal condyle of the femur. Then, coursing outwards and forwards, it passes up the inner side of the thigh and terminates in the upper part of Scarpa's triangle in the femoral vein.

The **External Saphenous** vein is formed by the veins on the outer side of the sole and dorsum of the foot. It passes behind the external malleolus and up the back of the leg to the lower part of the popliteal space, where it enters the popliteal vein.

SECTION XII

LYMPHATIC SYSTEM

The **Lymphatic System** is the means by which the liquid portion of the blood which exudes into the intercellular spaces is gathered up and returned to the blood, passing through the lymphatic glands on its way. The *lymph capillaries* gather up the fluid from the spaces, and enter a definite system of vessels, which carry the lymph to the groups of glands. Vessels leave these glands, and the lymph is carried to its final destination in the big veins at the root of the neck by one of the two terminal lymph vessels.

The **Thoracic Duct** is the larger of the two terminal vessels. It commences in the *Receptaculum chyli* (really a dilation of the vessel) which lies beneath the right crus of the diaphragm. The duct passes through the aortic opening in the diaphragm, and passes up on the right of the vertebral column. At the level of the fifth thoracic vertebra it crosses over to the left side, and passes up to enter the left innominate vein. The Receptaculum chyli receives the lymph from the lower extremities and the whole of the abdomen. The thoracic duct receives lymph from the left half of the thorax, the left upper extremity, and the left side of the head and neck.

The **Right Lymphatic Duct** is a very short vessel, not always present, about an inch long, which enters the right innominate vein. It receives lymph from the right half of the thorax, right upper extremity, and the right side of the head and neck.

The **Lymphatic Glands** and their vessels are arranged in two sets—superficial and deep—and are usually to be found on the course of the big veins and large spaces where there is connective tissue. The two sets anastomose with one another freely.

Head and Neck.

Occipital Glands, upon the upper part of trapezius or complexus, drain the occipital region of the scalp and upper and back part of the neck.

Mastoid Glands, on the upper part of sterno-mastoid and the mastoid bone, drain the parietal region of the scalp and the ear.

Facial Glands, small glands in different parts of the face, including several small groups situated beneath and behind the masseter muscle, draining the different parts of the face.

Superficial Cervical Glands lie superficial to the sterno-mastoid along the course of the external jugular veins. They drain the superficial part of the neck and mastoid region. There are also numerous small groups draining the tongue, front of the neck, pharynx, and larynx (see Fig. 59).

Deep Cervical Glands are in two groups, one beneath the sterno-mastoid lying along the course of the internal jugular vein. The other, embedded among the cords of the brachial plexus, is termed the supraclavicular group. These glands receive tributaries from the surrounding tissues and the groups of glands above them.

Upper Extremity.

Antecubital Glands, two or three small glands in front of the elbow, which drain the anterior surface of the forearm. They are not always present.

Axillary Glands.—These are arranged in four groups—(1) along the axillary vessels, (2) along the upper part of the axillary and the subclavian vessels, (3) between pectoralis major and serratus magnus, (4) along the subscapular vessels on the posterior wall of the axilla. They drain the upper limb and adjacent parts.

The **Superficial Lymphatic Vessels** of the upper limb begin by fine plexuses on the fronts of the fingers and palms of the hand. These converge to form vessels running along the sides of the fingers and back of the hand, and finally larger vessels are formed which follow the course of the veins and receive tributaries from the surrounding tissues, passing up to join the

antecubital and axillary glands. The **Deep Lymphatic Vessels** commence in the deeper tissue, and follow the course of the deep vein to the glands.

Lower Extremity.

Anterior Tibial Gland, on the front of the upper part of the interosseous membrane, drains the front of the leg.

Popliteal Glands, several glands in the popliteal space lying along the course of the vessels. These receive the tributaries from the anterior tibial gland and from the calf of the leg and foot.

Femoral Glands are in two sets—superficial and deep. They are all in Scarpa's triangle, arranged along the course of the vessels and along Poupart's ligament. They drain the whole of the lower limb.

The **Lymphatic Vessels** of the lower extremity are arranged in a very similar manner to those of the upper.

Trunk.

There are a large number of groups of glands in the abdomen and thorax which lie along the course of the vessels and in connection with the organs, and enter mainly the thoracic duct as described above. The lateral walls of the trunk are drained by the axillary and femoral groups of glands. The anterior walls are drained by some of the visceral groups, and the back is drained by groups of glands lying along the front of the vertebral column.

SECTION XIII

BRAIN, SPINAL CORD, NERVES OF TRUNK, AND SYMPATHETIC SYSTEM

THERE are two nervous systems described in the body—the cerebro-spinal and sympathetic. The cerebro-spinal can be divided into central and peripheral parts, the central part con-

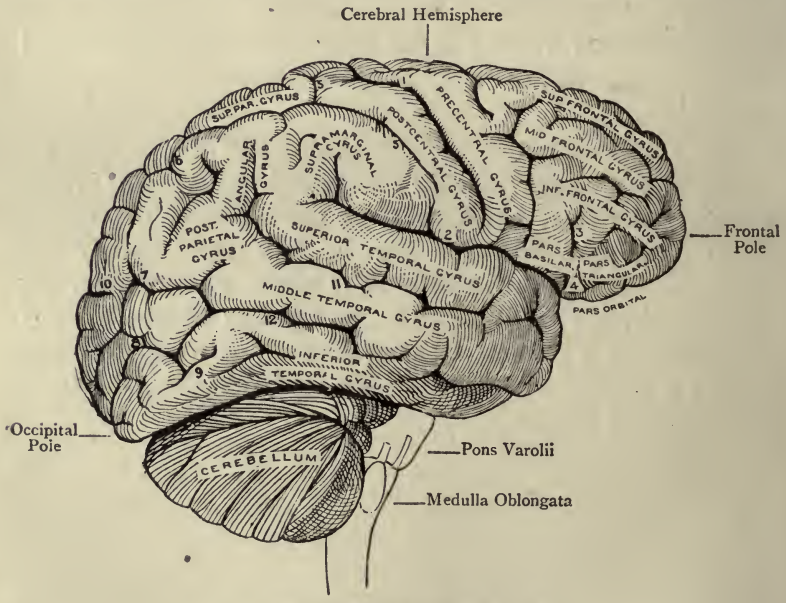


FIG. 60.—THE BRAIN (SIDE VIEW).

sisting of the brain and spinal cord, which send branches to the periphery. The sympathetic system consists of two chains of ganglia which communicate with the peripheral part of the cerebro-spinal system by means of efferent and afferent branches.

The brain is enclosed by the cranium, and the lower and hind-part of the brain, called the medulla, is prolonged through the foramen magnum of the occipital bone into the vertebral canal. The upper part of the brain—the cerebrum—is the larger; it is divided longitudinally by a deep cleft into two halves, each of which are divided again into lobes, correspond-

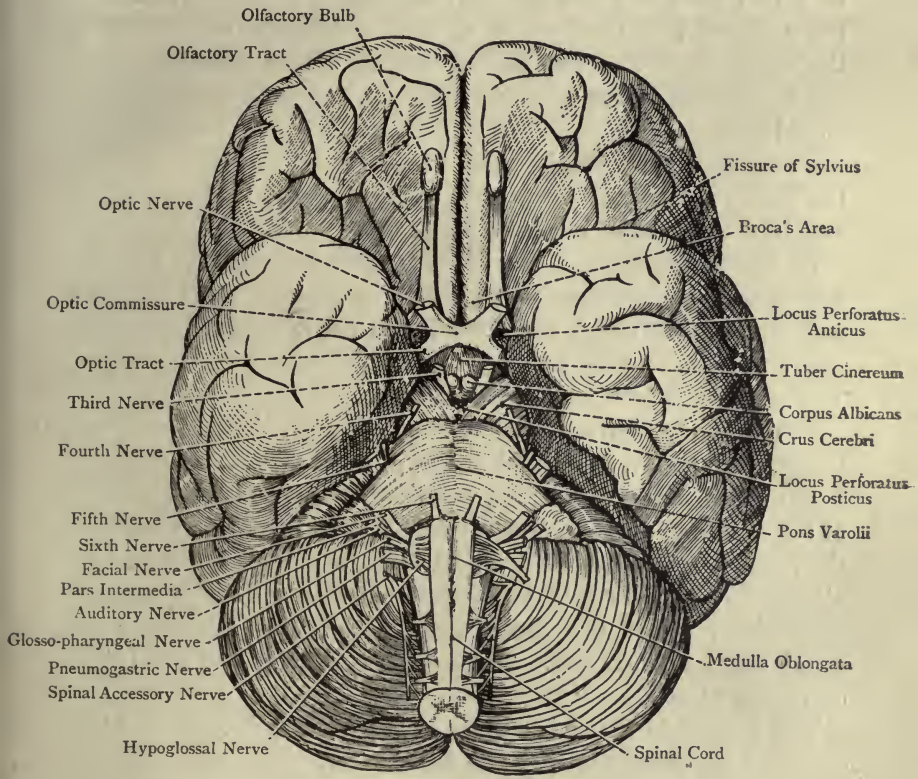


FIG. 61.—BASE OF THE BRAIN.

ing with, in shape and position, the bones of the cranium—namely, frontal, parietal, temporal, and occipital. These are again subdivided by numerous clefts or sulci. Beneath the occipital lobes of the cerebrum lies the cerebellum, or hind-brain, much smaller than the cerebrum. It also is divided longitudinally into two principal lobes, which are again subdivided by

sulci, which, however, are very much shallower than those of the cerebrum.

Looking at the base of the brain, it is seen that two thick cords of white matter issue from the cerebrum. These are called the cerebral peduncles, and joining them together is the pons varolii, which is seen to consist of transverse fibres, the ends of which pass into the cerebellum. Below the pons varolii is the upper end of the bulb or medulla oblongata, which lies on the upper aspect of the basilar process of the occipital bone.

The medulla tapers somewhat sharply, and is continued as the spinal cord.

From each side of the pons varolii and the medulla, issue the larger number of the twelve pairs of cranial nerves, which supply the tissues of the head and neck.

In transverse section the brain is seen to consist of white matter with a covering about quarter of an inch thick of grey matter, both of which are folded into convolutions and sulci. There are also nuclei of grey matter embedded in the white. The cerebellum is of similar structure.

The brain has three membraneous coverings, named, respectively, dura mater, arachnoid mater, and pia mater.

The *Dura Mater* is a tough membrane which lines the inside of the cranium, and is closely attached to it. It dips down into the great longitudinal fissure, and forms a pocket, or sinus. It also sends a process into the fissure between the cerebrum and cerebellum, called the tentorium cerebelli, in the edges of which are found sinuses. These sinuses are for the collection of venous blood.

The *Arachnoid Mater* is a more or less areolar structure which connects the pia mater with the dura mater.

The *Pia Mater* is a very thin epithelium which covers the brain substance, and follows intimately all the convolutions and sulci. In it numerous small bloodvessels ramify.

Blood-Supply of the Brain.

The blood-supply of the brain is very free, and is derived from four large arteries—the *internal carotid* and *vertebral* arteries of each side. These enter through the carotid canal in the

temporal bone and the foramen magnum respectively. On the lower surface of the medulla they anastomose together to form the circle of Willis, from which branches are derived which supply freely the different parts of the brain.

There are no veins proper in the brain; the venous blood is collected in the blood-spaces or sinuses in the dura mater, which finally leave the cranium by the jugular foramina as the internal jugular veins.

The Spinal Cord.

The spinal cord occupies the upper two-thirds of the vertebral canal. It extends from the margin of the foramen magnum of the occipital bone to the level of the upper border of the second lumbar vertebra. At its upper end it is continuous with the medulla oblongata of the brain, at its lower end it tapers, forming a pointed extremity called the conus medullaris, from the end of which comes a slender thread called the filum terminale. The cord is a cylindrical structure, slightly flattened before and behind, and is considerably smaller than the canal, which allows movements of the vertebral column to take place without jarring the cord.

The cord has three coverings continuous with those of the brain—viz., dura mater, arachnoid mater, and pia mater. The cord is suspended within the dura mater by two ligaments, which project laterally in its whole length, called the ligamenta denticulata. These extend outwards, and are attached to the inner surface of the dura mater by tooth-like projections.

The cord is not of uniform thickness throughout, but is considerably thickened in the lower cervical and upper lumbar regions. The cord similarly to the brain has a longitudinal fissure running down its posterior surface, which grooves it nearly to the centre. There is a shallower anterior furrow, and two very shallow grooves, one on each side of the posterior crus. These are called the postero-lateral grooves.

On transverse section the cord is seen to consist also of grey and white matter, but the grey matter is entirely embedded in the white, and has a minute central canal running through it, which communicates above with one of the ventricles of the brain. The grey matter forms a column which extends

the whole length of the cord, and in transverse section resembles in shape the letter **H**, the four ends of which are called horns.

There are thirty-one pairs of spinal nerves, which are attached by two roots each to the lateral aspects of the cord opposite the anterior and posterior horns of grey matter on each side respectively. These nerves come through the intervertebral foramina, and are named according to the vertebræ below which they emerge, except in the case of the cervical ones. The first nerve comes out between the occipital bone and the atlas, so that there are eight pairs of cervical nerves, twelve pairs of dorsal nerves, five pairs of lumbar nerves, five pairs of sacral nerves, and one pair of coccygeal nerves. As the cord itself ends in the upper lumbar region, the lower nerves lie in the vertebral canal, forming what is known as the cauda equina, and emerging in order through the intervertebral foramina.

The spinal nerves are attached to the cord by two roots—anterior and posterior—which join together inside the vertebral canal so that a mixed nerve—*i.e.*, formed by the junction of the two roots—emerges from the intervertebral foramen. It immediately divides into anterior and posterior divisions.

The posterior divisions supply the skin at the back of the head, neck, shoulder, buttock, and trunk, and the longitudinal muscles of the back. Each divides into two parts—an internal and external trunk. In the upper half of the body the internal trunks are cutaneous, the external ones muscular; in the lower half of the body the reverse is the case. The posterior divisions of the first and second cervical nerves vary a little.

First cervical nerve (suboccipital) does not divide into internal and external trunks, and gives off no cutaneous branches. Muscular branches to complexus, rectus capitis posticus major and minor, obliquus superior and inferior.

Second cervical nerve (great occipital) supplies the skin at the back of the head as far as the vertex, and communicates with the other cutaneous nerves of that region.

Muscular branches to complexus, obliquus inferior, and other muscles on the back of the neck.

Third cervical nerve is called the least occipital nerve, and is rather small, but its distribution is similar to that of the posterior divisions of the other spinal nerves.

The anterior divisions of the rest supply the trunk and the limbs. They form what are called plexuses, which are groups of nerves joined up together. There are five plexuses—viz.:—

Cervical plexus, formed by cervical nerves 1, 2, 3, and 4, supplies the muscles and skin of the neck.

Brachial plexus, formed by cervical nerves 5, 6, 7, 8, and a branch of the first dorsal nerve, supplies the upper limb.

Lumbar plexus, formed by a branch of the twelfth dorsal nerve, lumbar nerves 1, 2, 3, and a branch of the fourth lumbar nerve, supplies the anterior, inner, and outer surfaces of the thigh.

Sacral plexus, formed by lumbar nerves 4 and 5, and sacral nerves 1, 2, 3, supplies buttock, posterior surface of thigh and leg and foot.

Pudendal plexus, formed by a branch of the third sacral nerve, sacral nerves 4 and 5, and the coccygeal nerve, supplies the perineum.

The *anterior divisions* of the twelve dorsal or thoracic nerves supply the skin and muscles on the anterior and lateral surfaces of the trunk. The first eleven are intercostal, the twelfth lies below the last rib.

The **Intercostal Nerves** are much alike in their course and distribution, but some of them differ slightly from the others.

A typical thoracic nerve enters the posterior end of the subcostal groove, and lies between the intercostal muscles. Coursing forwards, it pierces the internal intercostal muscle about the middle of the chest wall, and lies on the pleura. Near the middle line it pierces again the internal intercostal muscle and the aponeurosis of the external intercostal, and supplies the skin over the front of the chest corresponding to the anterior half of the space to which it belongs.

Branches.—Cutaneous, a lateral cutaneous branch is given off in the mid-axillary line to the skin over the space to which it belongs; it divides into anterior and posterior branches.

Muscular, to the intercostal muscles.

First thoracic nerve divides into two parts. The upper larger part passes over the neck of the first rib, enters the neck behind the subclavian artery, and joins with the other nerves forming

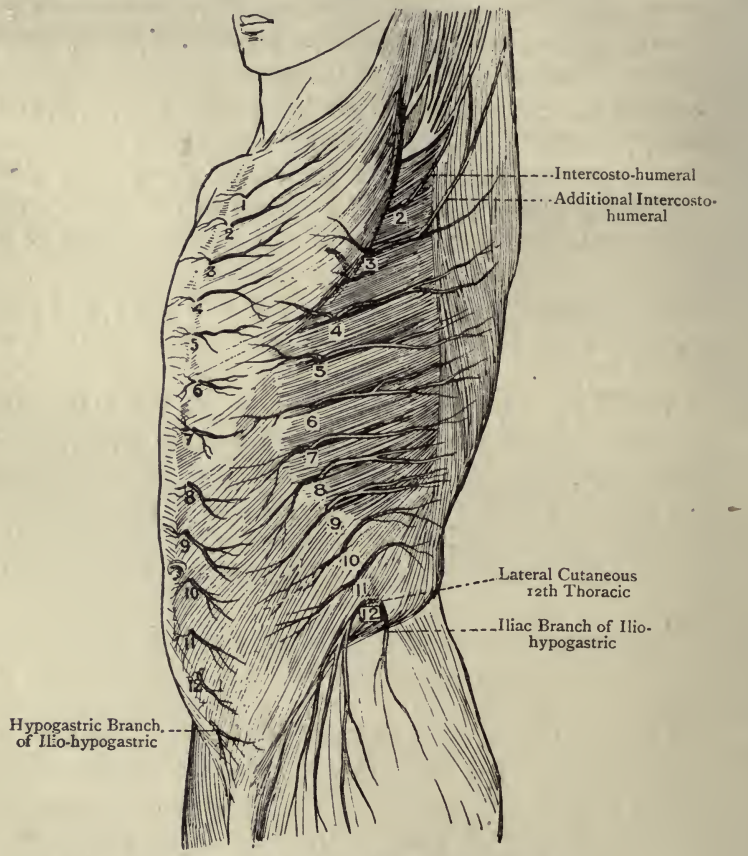


FIG. 62.—CUTANEOUS NERVES OF TRUNK.

the brachial plexus. The lower part enters the subcostal groove and supplies the intercostal muscles, but as a rule has no cutaneous branches.

Second thoracic nerve has the same course as a typical thoracic nerve, but the lateral cutaneous branch, called the intercosto-

humeral nerve, is of unusually large size. It crosses the axilla and supplies the skin of the armpit, and the inner side of the posterior surface of the arm as far as the elbow.

Third thoracic nerve is a typical one, except that the posterior half of the lateral cutaneous branch also extends into the arm, and supplies a small portion of the posterior surface of the root of the limb.

Fourth, fifth, and *sixth thoracic* nerves are typical.

Seventh, eighth, ninth, tenth, and *eleventh thoracic* nerves at the anterior ends of their intercostal spaces pierce the attachment of the diaphragm and the transversalis abdominis, and pass forwards between the latter and obliquus internus. Their anterior ends become cutaneous by piercing the sheath of the rectus and the muscle itself. They supply the intercostal muscles of their own spaces and the abdominal muscles, and help to supply the diaphragm. Their cutaneous branches are similar to those of the typical nerves.

Twelfth thoracic nerve passes downwards under psoas and then passes forwards, similarly to those just above it. It gives off a large lateral cutaneous branch, which, passing down between the abdominal muscles, becomes cutaneous just above the iliac crest, and supplies the skin of the buttock as far down as the great trochanter of the femur.

The Sympathetic System.

The sympathetic system consists of two long chains of ganglia lying one on each side of the vertebral column, extending from the base of the skull to the coccyx. The ganglia are connected to the spinal cord by white rami communicantes given off by some of the spinal nerves (second thoracic to second lumbar and three or four sacral) as they emerge from the intervertebral foramina. The ganglia send grey rami communicantes back to the cord. Above, the chain ends by a plexus of nerves sent into the cranial cavity on the internal carotid artery, and below, the two terminal ganglia communicate with one another.

The ganglia send branches of supply to vessels, viscera, involuntary muscles, and glands.

In the cervical region there are only three ganglia on each side, but below this there is a ganglion on each side opposite each vertebra.

The ganglia in the cervical and thoracic regions form plexuses on the vessels in their vicinity, and also form plexuses to supply the pharynx, larynx, heart, and lungs. In addition they communicate with the lumbar ganglia by means of the splanchnic nerves, which pierce the diaphragm to join the solar plexus.

The *Splanchnic Nerves*, three in number, are formed by branches from the fifth to the twelfth thoracic ganglia.

The *Solar Plexus* consists of three parts—the cœliac plexus and the two semilunar ganglia. They lie behind the stomach, on the aorta, just above the cœliac axis. They send out branches, which form subsidiary plexuses, accompanying the branches of the artery to the various organs.

The *Aortic Plexus* is the continuation on the front of the aorta of the solar plexus, and, like the latter, forms subsidiary plexuses on the branches of the vessel.

SECTION XIV

CERVICAL PLEXUS

The cervical plexus is formed by the anterior primary divisions of the first four cervical nerves. The nerves emerge from the intervertebral foramina behind the vertebral artery, and each nerve is joined at once by a communicating branch from the sympathetic ganglion. The plexus lies on the scalenus medius muscle, and is covered by sterno-mastoid. The four nerves join with another, forming a series of loops, from which the branches of distribution arise.

Branches.—(1) *Cutaneous* to head, neck, and shoulder.

(2) *Muscular* to muscles of neck and diaphragm.

(3) *Communicating* to vagus, spinal accessory, hypoglossal, and sympathetic.

(1) The **Cutaneous** branches appear in the posterior triangle of the neck. The three ascending ones turn upwards over posterior border of sterno-mastoid, the three descending ones to the clavicular region.

Ascending Branches : (*a*) *Small occipital* supplies skin on back of ear and on scalp over mastoid process.

(*b*) *Great auricular* crosses sterno-mastoid obliquely upwards, and supplies the scalp behind the ear, the lower part of the pinna, and the skin over the lower part of the masseter and the parotid gland.

(*c*) *Superficial cervical* crosses straight over the sterno-mastoid and supplies the skin over the anterior triangle of the neck.

Descending Branches: One large trunk is formed whic descends from beneath sterno-mastoid. It extends through the posterior triangle of the neck and supplies the skin over the

clavicle by dividing into three parts—sternal, clavicular, and acromial.

(2) The **Muscular** branches of the plexus are in two sets—internal and external, according to their relation to the sterno-mastoid muscle.

External branches passing outwards to posterior triangle

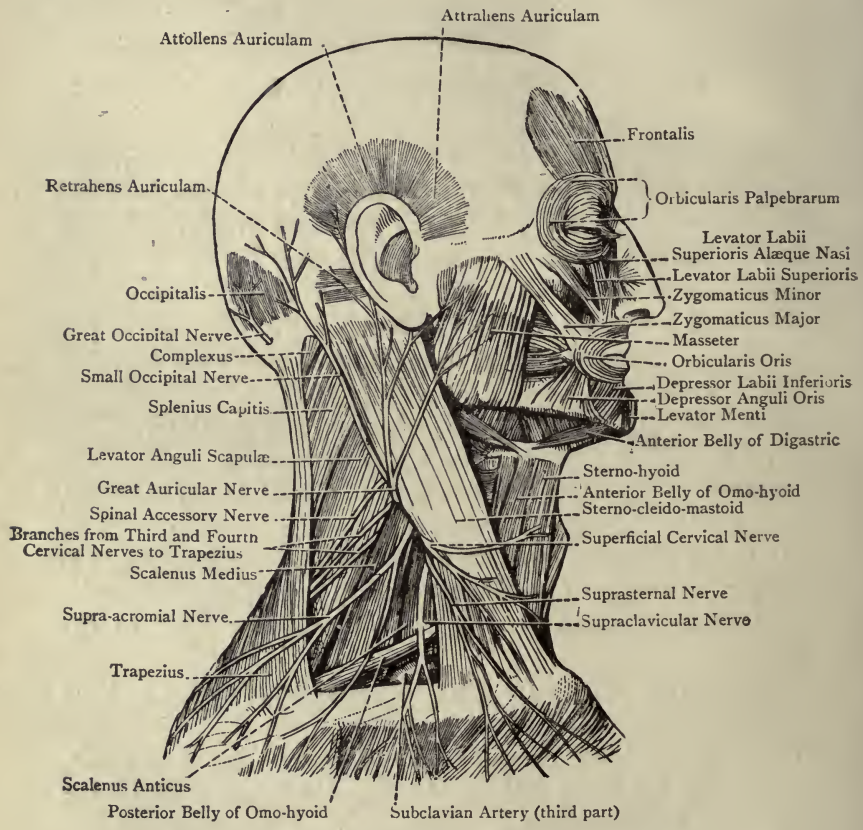


Fig. 63.—Nerves in Posterior Triangle of Neck.

supply sterno-mastoid, levator scapulæ, trapezius and the scaleni, and communicate with the spinal accessory nerve.

Internal branches passing inwards to anterior triangle supply the prevertebral muscles, genio-hyoid, and infrahyoid muscles,

and communicate with the vagus and hypoglossal. There is a special branch to the diaphragm called the phrenic nerve.

The *Phrenic* nerve is formed by branches from the third, fourth, and fifth cervical nerves. It passes down on scalenus anticus, and enters the thorax between the subclavian artery and

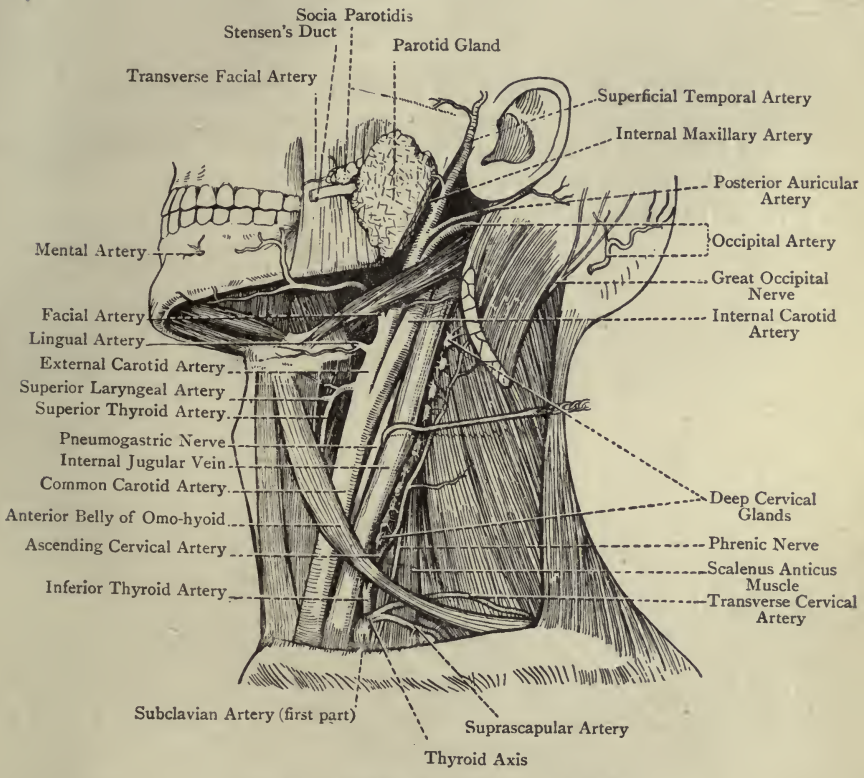


FIG. 64.—VESSELS AND NERVES IN NECK.

vein. It reaches the diaphragm by passing between the pericardium and pleura in front of the root of the lung. The nerve gives off some branches to the upper surface of the diaphragm, then pierces the muscle and supplies the under surface. It also gives off pleural, pericardial, and hepatic branches.

SECTION XV

BRACHIAL PLEXUS AND NERVES OF UPPER LIMB

The **Brachial Plexus** is formed by the anterior division of the fifth, sixth, seventh, and eighth cervical nerves, and the greater part of the first thoracic nerve. The second thoracic nerve,

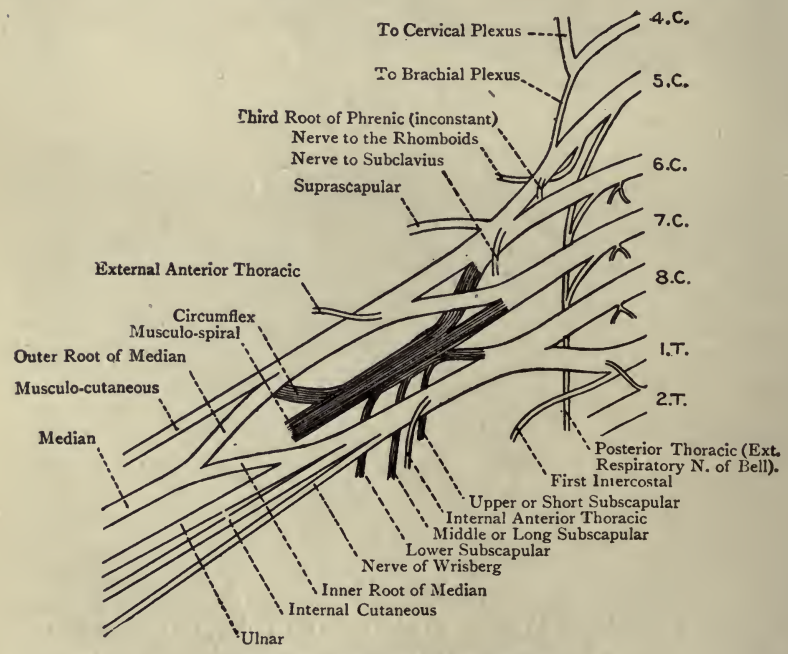


FIG. 65.—THE BRACHIAL PLEXUS.

although not part of the plexus, helps in the innervation of the arm through the intercosto-humeral nerve.

The nerves forming the plexus appear in the posterior triangle

of the neck, and, passing between scalenus medius and anticus with the subclavian artery, they accompany the axillary artery to the shoulder and upper limb.

As the nerves enter the posterior triangle they form the three primary cords—

First primary cord : Fifth and sixth nerves joined together.

Second primary cord : Seventh nerve alone.

Third primary cord : Eighth cervical and first thoracic joined together.

As soon as the three cords are formed they each divide into anterior and posterior divisions to form the secondary cords, which are named according to their relation to the axillary artery.

Outer cord : Anterior divisions of first and second primary cords.

Inner cord : Anterior division of third primary cord.

Posterior cord : Posterior divisions of all three primary cords.

The nerves supplying the shoulder and arm are derived from these three cords—viz. :

Outer cord : Musculo-cutaneous, outer head of median, external anterior thoracic nerves.

Inner cord : Ulnar, inner head of median, internal anterior thoracic, internal cutaneous, and lesser internal cutaneous nerves.

Posterior cord : Circumflex, three subscapular and musculo-spiral nerves.

Before the nerves join up to form the cords, a few branches are given off which are called *Supraclavicular* nerves to distinguish them from the branches derived from the secondary cords which are called the *Infraclavicular* nerves.

Supraclavicular Nerves.—*Muscular branches* to scaleni, subclavius, and longus colli.

Posterior scapular supplies the rhomboids and levator anguli scapulæ.

Long thoracic supplies serratus magnus. It pierces scalenus medius and enters the axilla between the artery and serratus magnus. This nerve is also called the respiratory nerve of Bell.

Suprascapular supplies supra- and infraspinatus and articular branches to the shoulder-joint. It passes down to the superior

border of the scapula, then through the suprascapular foramen and winds round the great scapular notch.

Infraclavicular Nerves.—The anterior set from the inner and outer cords supply the chest and front of the limbs, the posterior set of nerves from the posterior cord supply the shoulder and the back of the limb.

Anterior Thoracic Nerves.—The external anterior thoracic nerve arises from the outer cord, and the internal one from the inner cord. They pass down one on each side of the axillary artery, and are finally distributed to pectoralis major and minor.

Musculo-Cutaneous nerve from the outer cord lies first between coraco-brachialis and the axillary artery; it then lies between biceps and brachialis to the bend of the elbow. It becomes cutaneous between biceps and brachio-radialis, and ends by supplying the skin on the outer side of the forearm.

Branches.—Muscular to biceps, brachialis anticus and coraco-brachialis (this last nerve is not really a branch of musculo-cutaneous, but is an independent branch from the sixth and seventh cervical nerves incorporated with it).

Cutaneous.—Anterior branch supplies the outer half of the anterior surface of the forearm as far as the ball of the thumb. The posterior branch supplies the upper three-fourths of the outer half of the posterior surface of the forearm.

Median nerve arises by two roots—one from the outer cord and one from the inner. The outer head passes down on the outer side of the axillary artery, and the inner head crosses over at the beginning of the brachial artery to join it. The complete nerve then passes down on the outer side of the brachial artery, and crosses over it to the inner side, at the level of the inferior profunda branch about the middle of the arm. At the elbow it lies on the inner side of the artery beneath the bicipital fascia and the median basilic vein, and passes into the forearm between the two heads of pronator radii teres, the deep head of which separates the nerve from the ulnar artery. The nerve then passes down the forearm between the superficial and deep muscles, and enters the palm of the hand beneath the anterior annular ligament on the outer side of the flexor tendons. In the

hand it lies beneath the palmar fascia and superficial palmar arch, and divides into its six terminal branches.

Branches.—There are none in the upper arm.

In the forearm: 1. *Articular* to the elbow-joint.

2. *Muscular* to pronator radii teres, palmaris longus, flexor carpi radialis, flexor sublimis digitorum, flexor longus pollicis, and flexor profundus digitorum.

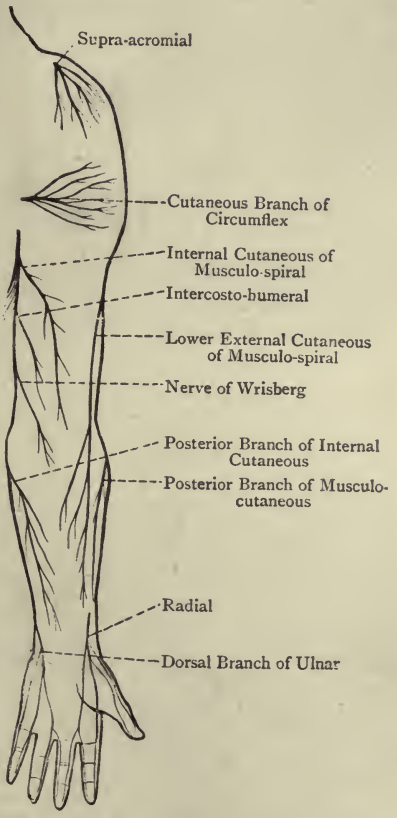


FIG. 66.—CUTANEOUS NERVES OF UPPER LIMB (POSTERIOR SURFACE).

3. *Anterior Interosseous* passes down the anterior surface of interosseous membrane with the artery of the same name and beneath the pronator quadratus. It terminates by supplying the wrist-joint, and in its course supplies flexor longus pollicis, outer

half of flexor profundus digitorum, pronator quadratus, and twigs to the bones, periosteum, and interosseous membrane.

4. *Palmar Cutaneous* branch (not always present) arises in the lower third of the forearm, pierces the deep fascia, and supplies the skin of the palm.

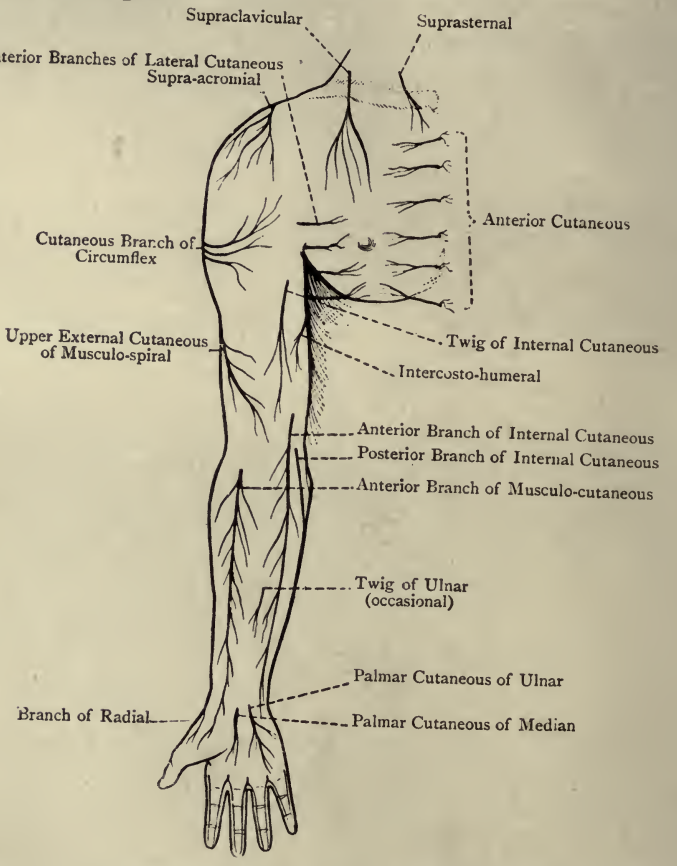


FIG. 67.—CUTANEOUS NERVES OF UPPER LIMB (ANTERIOR SURFACE).

In the hand: 1. *Muscular* to abductor pollicis, opponens pollicis, superficial head of flexor brevis pollicis, and the two lumbricales on the radial side.

2. *Cutaneous* to the skin of the thumb, the first and second fingers, and the radial half of the third finger. These nerves

turn over the tops of the fingers and supply the posterior surface of the terminal phalanges.

Ulnar nerve arises from the inner cord of the brachial plexus. It lies between the axillary artery and vein, and passes down on the inner side of the brachial artery in front of triceps. In the lower half of the arm it passes behind the internal intermuscular septum with the inferior profunda artery lying anterior to the inner head of triceps, and reaches the interval between the internal condyle of the humerus and the olecranon process. It enters the forearm between the two heads of flexor carpi ulnaris and passes down between it and flexor profundus digitorum on the inner side of the ulnar artery. It passes into the hand over the anterior annular ligament on the radial side of the pisiform bone, and divides beneath palmaris brevis into its terminal branches.

Branches.—There are none in the upper arm.

In the forearm : *Articular* to the elbow-joint.

Muscular to flexor carpi ulnaris and the inner half of flexor profundus digitorum.

Cutaneous.—Palmar supplies the skin over the ulnar side of the wrist, the hypothenar eminence, and ulnar side of palm. Dorsal supplies the skin on the ulnar side posterior surface of wrist and hand, the little finger and ulnar side of third finger.

In the hand: *Muscular* to palmaris brevis. It then divides into terminal branches superficial and deep.

Superficial.—Cutaneous to anterior surface of little finger and ulnar side of third finger.

Deep.—Muscular to all the muscles of the hand except those supplied by the median nerve.

Internal Cutaneous nerve arises from the inner cord of the brachial plexus. In the upper part of its course it lies superficial to the artery and the ulnar nerve. It then pierces the deep fascia about the middle of the inner side of the arm, and accompanies the basilic vein to the elbow, where it divides into its two terminal branches.

Branches.—In the upper arm a branch which supplies the lower half of the anterior surface on its inner side.

In the forearm there are two branches—one supplies the

anterior surface of the inner side of the forearm as far as the wrist, the other supplies the upper three-fourths of the posterior surface of the inner side.

Lesser Internal Cutaneous arises from the inner cord of the brachial plexus. It supplies the skin of the upper half of the arm on the inner side.

Circumflex nerve from the posterior cord passes down behind the axillary artery and goes through the quadrilateral space in company with the posterior circumflex artery. It winds round the surgical neck of the humerus and ends in the deltoid (see Fig. 6).

Branches.—*Muscular* to the teres minor and deltoid muscles.

Articular to the shoulder-joint.

Cutaneous to the skin over the deltoid and upper half of the arm.

The **Musculo-Spiral** nerve is the continuation of the posterior cord of the brachial plexus. It passes through the axilla behind the axillary artery, and down the arm behind the brachial artery on the long head of triceps. It then courses downwards and outwards in the musculo-spiral groove with the superior profunda artery, separating the heads of the triceps. The nerve then pierces the external intermuscular septum, and lies in front of the external condyle of the humerus between brachialis anticus and supinator longus, where it ends by dividing into the radial and posterior interosseous nerves.

Branches.—On the inner side of the humerus:

1. *Internal Cutaneous* supplies the skin of the upper third of the inner side of the arm.

2. *Muscular* to the three heads of triceps.

At the back of the humerus:

Muscular to the three heads of triceps and anconeus.

On the outer side of the humerus:

1. *Cutaneous.*—A *superior* branch supplies the skin on the outer side and back of the lower third of the arm and the upper half of the back of the forearm. An *inferior* branch supplies the skin in the upper two-thirds of the back of the forearm on the inner side of the area supplied by the musculo-cutaneous nerve.

2. *Muscular* to brachialis anticus, supinator longus, and extensor carpi radialis longior.

3. *Radial* nerve passes down the upper two-thirds of the forearm external to the radial artery and covered by supinator longus. It pierces the deep fascia on the outer side of the lower third of the forearm, and passes to the back of the wrist. It supplies the skin on the back of the wrist, the radial side of the back of the hand and the back of the thumb, first and second fingers, and radial side of the third finger as far as the second phalanges, the rest being supplied by the median nerve.

4. *Posterior Interosseous* nerve is entirely muscular and articular in its distribution. It reaches the back of the forearm by passing from under supinator longus round the outer side of the radius, and pierces supinator brevis. On the back of the forearm it passes beneath the extensor muscles with the posterior interosseous artery, then gets on the interosseous membrane by passing beneath extensor longus pollicis, and terminates in a gangliform enlargement on the back of the wrist.

Branches.—Articular to the carpal joints.

Muscular to extensor carpi radialis brevis, supinator brevis, and all the extensor muscles on the back of the forearm.

Subscapular Nerves.—There are three subscapular nerves arising from the posterior cord of the brachial plexus. They all pass down behind the axillary artery, and are all purely muscular :

First or short subscapular nerve to subscapularis.

Second or lower subscapular nerve to teres major.

Third or long subscapular nerve to latissimus dorsi.

SECTION XVI

LUMBAR AND SACRAL PLEXUS AND NERVES OF LOWER LIMB

The anterior divisions of the remaining spinal nerves—viz., five lumbar, five sacral, and one coccygeal—form the lumbo-sacral plexus, which supplies the lower part of the trunk and the lower limb. For convenience of description the plexus is divided into three parts—lumbar, sacral or sciatic, and pudendal.

The *lumbar* plexus is formed by the first four lumbar nerves and a branch of the twelfth thoracic.

The *sacral* or sciatic plexus is formed by part of the fourth lumbar, the fifth lumbar, and the first three sacral nerves.

The *pudendal* plexus is formed by branches from the second and third sacral nerves, the fourth and fifth sacral nerves, and the coccygeal nerve. This plexus supplies mainly the perineum.

The **Lumbar Plexus** is formed by the anterior divisions of the first three lumbar nerves, a part of the fourth, and a small branch from the twelfth thoracic nerve. It is placed deeply in the substance of psoas just in front of the transverse processes of the lumbar vertebræ. On emerging from the intervertebral foramina, and after communicating with the sympathetic system, the nerves divide to form the plexus.

The first and second nerves divide into upper and lower parts. The upper part of the first nerve joins with the branch from the twelfth thoracic and forms the ilio-inguinal and ilio-hypogastric nerves. The lower part of the first nerve and the upper part of the second join to form the genito-crural nerve. The lower part of the second nerve, the third nerve, and the upper part of the fourth nerve divide into anterior and posterior parts. The anterior parts join to form the obturator nerve, and the posterior parts form the anterior crural nerve; from the posterior parts of

the second and third nerves, branches are given off, which join to form the external cutaneous nerve. Before these divisions take place branches are given off from the lumbar nerves to supply quadratus lumborum and psoas.

Ilio-Hypogastric Nerve, formed by the branch from the twelfth thoracic nerve and the upper part of the first lumbar nerve. It emerges from psoas, and passes between the trans-

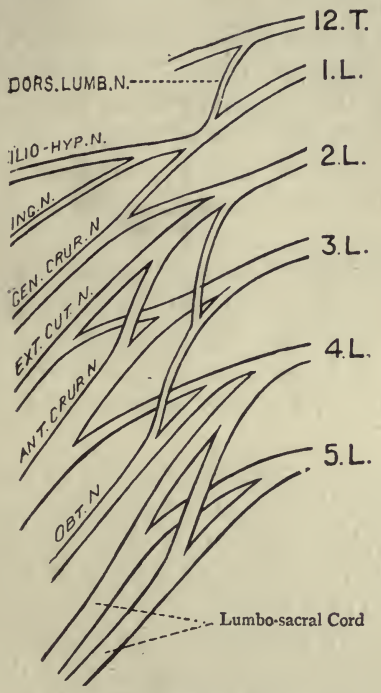


FIG. 68.—LUMBAR PLEXUS.

versalis and obliquus internus muscles above the crest of the ilium, and becomes cutaneous in the lower part of the anterior abdominal wall.

Branches.—*Muscular* to abdominal muscles.

Cutaneous.—Iliac branch which corresponds to the lateral cutaneous branches of the thoracic nerves, and supplies the skin over the upper part of the buttock. Hypogastric branch, which supplies the skin over the pubis.

Ilio-Inguinal nerve in origin and course resembles the ilio-hypogastric nerve, but pierces the abdominal wall lower down, and becomes cutaneous by passing through the external abdominal ring and spermatic fascia.

Branches.—Muscular to the abdominal wall.

Cutaneous to skin over the symphysis pubis, the upper and inner part of Scarpa's triangle, and the upper part of the external genital organs.

Genito-Crural nerve arises from the first and second lumbar nerves, which unite in the substance of psoas. The nerve passes down on the outer side of the external iliac vessels and becomes cutaneous just above Poupart's ligament, and supplies the skin over Scarpa's triangle, external to the ilio-inguinal nerve. A small branch passes upwards to the external genital organs.

External Cutaneous nerve arises from the second and third lumbar nerves. The nerve crosses the iliacus muscle to the anterior superior spine of the ilium. It then pierces the origin of sartorius, and becomes cutaneous a few inches below this point, where it divides into anterior and posterior terminal branches.

Branches.—Anterior supplies the skin on the outer side of the front of the thigh almost to the knee.

Posterior supplies the skin on the outer side of the buttock below the great trochanter and the skin of the upper two-thirds of the outer side of the thigh.

Obturator nerve arises from the second, third, and fourth lumbar nerves. The nerve emerges from the inner border of psoas behind the common iliac vessels. It passes forwards with the obturator artery, and goes through the groove in the thyroid foramen, where it divides into two branches—superficial and deep. This nerve supplies the muscles and skin on the inner side of the thigh.

The *Superficial* part of the obturator nerve enters the thigh beneath pectineus, and, passing down the inner border of adductor longus, anterior to gracilis, it finally divides into two terminal branches, one of which enters Hunter's canal.

Branches.—Articular to the hip-joint.

Muscular to adductor longus, gracilis, adductor brevis, and pectineus (occasionally).

Cutaneous becomes superficial in the middle third of the thigh, and supplies skin of the lower two-thirds of the inner side of the thigh, and ends in the subsartorial plexus. The terminal branch, which enters Hunter's canal, ramifies over the femoral artery.

The *Deep* part of the obturator nerve pierces obturator externus and passes down between adductor brevis and adductor magnus; it then passes through adductor magnus, and, entering the popliteal space, terminates by supplying the knee-joint.

Branches.—Muscular to obturator externus, adductor magnus and adductor brevis (if not already supplied by the superficial part).

Articular to the knee-joint.

The **Anterior Crural** nerve arises from the second, third, and fourth lumbar nerves behind the obturator nerve. It is formed in the substance of psoas, and, emerging from its outer border, it passes down between psoas and iliacus, and enters the thigh by passing under Poupart's ligament on the outer side of the femoral vessels. In Scarpa's triangle it breaks up into branches to supply the front of the thigh.

Branches.—In the abdomen: *Muscular* to iliacus.

In Scarpa's triangle: *Muscular* to pectineus, sartorius, and quadriceps extensor.

Articular to the hip and knee joints.

Cutaneous.—The cutaneous branches are in three sets—middle and internal cutaneous and long saphenous.

Middle Cutaneous nerve arises in two parts—the external and internal. They supply the skin on the lower three-fourths of the front of the thigh, and end in the patellar plexus.

Internal Cutaneous nerve lies in Scarpa's triangle on the outer side of the femoral vessels, over which it crosses, and, dividing into three branches, all of which terminate in the patellar plexus, supplies the skin on the lower two-thirds of the inner side of the thigh.

The *Long Saphenous* nerve arises in Scarpa's triangle. It passes down with the femoral vessels through Hunter's canal, at the lower end of which it crosses over the tendon of adductor

magnus and becomes cutaneous on the inner side of the knee-joint by passing between sartorius and gracilis. It passes down the inner side of the leg with the internal saphenous vein, and supplies the skin of the front and inner side of the leg and posterior half of the dorsum and inner side of the foot.

The **Patellar Plexus** is formed by the branches of the cutaneous nerves supplying the skin in front of the knee—viz.,

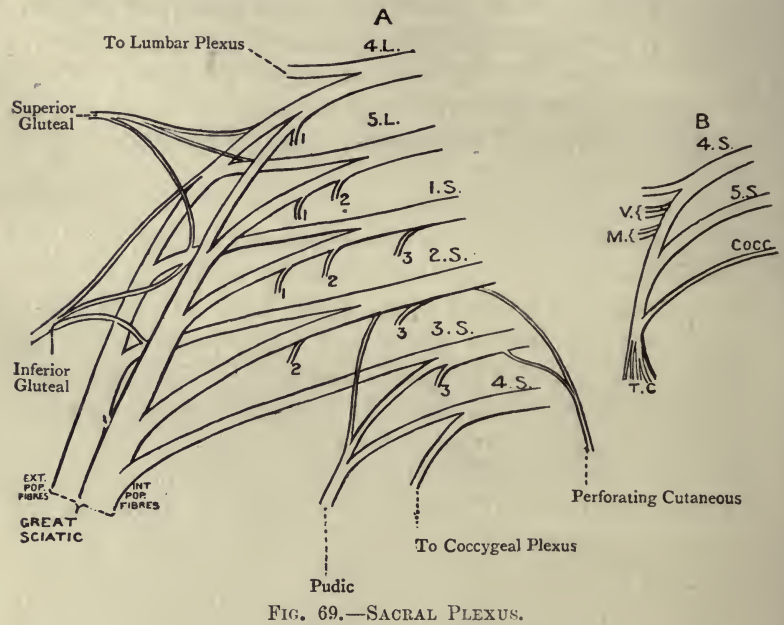


FIG. 69.—SACRAL PLEXUS.

A

1, 1, 1. Nerve to Quadratus Femoris
2, 2, 2. Nerve to Obturator Internus
3, 3, 3. Small Sciatic Nerve

B

4 S. Fourth Sacral, giving a Branch to Sacral Plexus
V. Visceral Branches
M. Muscular Branches
T.C. Terminal Cutaneous Branches

the long saphenous, internal and middle cutaneous, all branches of the anterior crural nerve, and sometimes a branch of the external cutaneous nerve.

The **Sacral or Sciatic Plexus** is formed by the anterior divisions of the fourth and fifth lumbar nerves and the first three sacral nerves. The plexus is formed on the anterior surface of pyriformis, all the nerves joining to form a large triangular trunk

which passes through the sacro-sciatic foramen as the great sciatic nerve, which supplies the back of the thigh and the whole of the leg and foot (excepting that part of skin supplied by the saphenous nerve); small branches arise from the anterior and posterior surfaces of the plexus to supply the parts in the vicinity. The great sciatic nerve ends at the popliteal space by dividing into tibial and peroneal nerves (internal and external popliteal nerves). In reality this division can be traced all the way up to the plexus, so that the nerve is really constituted in two parts, but for purposes of description it is easier to call the upper part one trunk—namely, the great sciatic.

The plexus is formed by the lower part of the fourth lumbar nerve joining the fifth lumbar nerve, which, known as the lumbo-sacral cord, passes into the pelvis over the sacro-iliac articulation, and on pyriformis joins the first and second and upper part of third sacral nerves. The three sacral nerves also send branches to the pudendal plexus, so that no distinct line can be drawn between them.

Branches from the plexus (other than great sciatic):

Anterior.—Muscular to quadratus femoris, obturator internus and gemelli.

Articular to hip-joint.

Posterior.—Muscular to pyriformis and glutei (superior and inferior gluteal nerves).

Articular to knee-joint (via the nerve to biceps).

Cutaneous to skin on back of thigh (small sciatic).

Superior Gluteal nerve arises from the fourth and fifth lumbar and the first sacral nerves. It passes through the sacro-sciatic foramen, with the gluteal artery above pyriformis, and supplies gluteus medius and minimus and tensor fasciæ femoris.

Inferior Gluteal nerve arises from the fifth lumbar and first and second sacral nerves. It passes through the sacro-sciatic foramen beneath pyriformis, and supplies gluteus maximus.

Small Sciatic nerve passes through the sacro-sciatic foramen below pyriformis, with the sciatic artery and inferior gluteal nerve. It enters the thigh at the lower border of gluteus maximus, and, piercing the deep fascia, it supplies the skin on the

back of the thigh and over the calf of the leg. It is a purely cutaneous nerve.

Branches.—Perineal arises at the lower border of gluteus maximus, and, passing inwards, supplies the skin over the perineum and external genital organs.

Gluteal arise beneath gluteus maximus, and, passing round its lower border, supply the skin over the lower half of the buttock.

Femoral in two sets—internal and external—supply the skin on the back of the thigh.

Sural.—Two or more branches which pierce the fascia over the popliteal space and supply the skin over the calf of the leg for a variable distance.

The **Great Sciatic** nerve passes through the sacro-sciatic foramen below pyriformis between it and the superior gemellus. Covered by gluteus maximus, it passes down, into the thigh, accompanied by the sciatic artery and a special artery of its own (arteria comes nervi ischiadici). It lies in the hollow between the great trochanter and the tuberosity of the ischium, and enters the thigh beneath the lower border of gluteus maximus. Lying between it and the origin of the hamstrings, it is comparatively superficial. In the thigh it lies on adductor magnus, and is covered by the hamstrings, and at a variable point between the sacro-sciatic foramen and the upper part of the popliteal space divides into the internal and external popliteal nerves.

Branches.—Muscular to the hamstrings and short head of biceps.

Articular to the knee-joint.

The External Popliteal Nerve.—One of the terminal branches of the great sciatic nerve passes beneath the tendon of biceps obliquely through the upper and outer part of the popliteal space; it then passes over the outer head of gastrocnemius, and just below the head of the fibula divides into its terminal branches, the anterior tibial and musculo-cutaneous nerves.

Branches.—Cutaneous to the skin over the calf of the leg. Peroneal communicating joins a similar branch from the tibial nerve to form the short saphenous nerve.

Muscular.—Recurrent tibial, which, passing forwards, supplies tibialis anticus (upper fibres).

Articular.—Branches to the knee-joint and tibio-fibular articulation from the recurrent tibial.

The **Anterior Tibial** nerve passes beneath peroneus longus and the extensors of the toes to the front of the leg. With the anterior tibial artery it lies on the interosseous membrane and the lower part of the tibia. Passing beneath the anterior annular ligament, it divides on the dorsum of the foot into its terminal branches.

Branches.—Muscular to tibialis anticus, extensor proprius hallucis, extensor longus digitorum and peroneus tertius, and extensor brevis digitorum (from its external terminal branch).

Articular to ankle-joint and tarsal and metatarsal joints (from its external terminal branch).

Cutaneous from the internal terminal branches. The nerve passes along the dorsum of the foot on the outer side of the dorsalis pedis artery and supplies the skin of the cleft, between the first and second toes.

The **Musculo-Cutaneous** nerve passes down the leg, lying between the peronei and the extensor muscles. In the lower third of the leg it pierces the deep fascia and divides into its two terminal branches—internal and external.

Branches.—Muscular to peroneus longus and brevis.

Cutaneous to the lower third of the skin of the leg, and, passing over the anterior annular ligament, to the dorsum of the foot, the inner side of the great toe and the skin of the clefts between the toes, not excepting the one also supplied by the anterior tibial nerve.

The **Internal Popliteal Nerve.**—One of the terminal branches of the great sciatic nerve, from the upper part of the popliteal space to the lower border of the popliteus muscle, where it is continued down the leg. It lies at first beneath semimembranosus; then, crossing the popliteal vessels to their inner side, it lies on popliteus and is covered by gastrocnemius and plantaris. It then passes down the back of the leg between the superficial and deep muscles with the posterior tibial vessels, at first on their inner side, but crossing over in the

middle of the leg the nerve lies on their outer side in the lower half. It divides into its terminal branches, the internal and

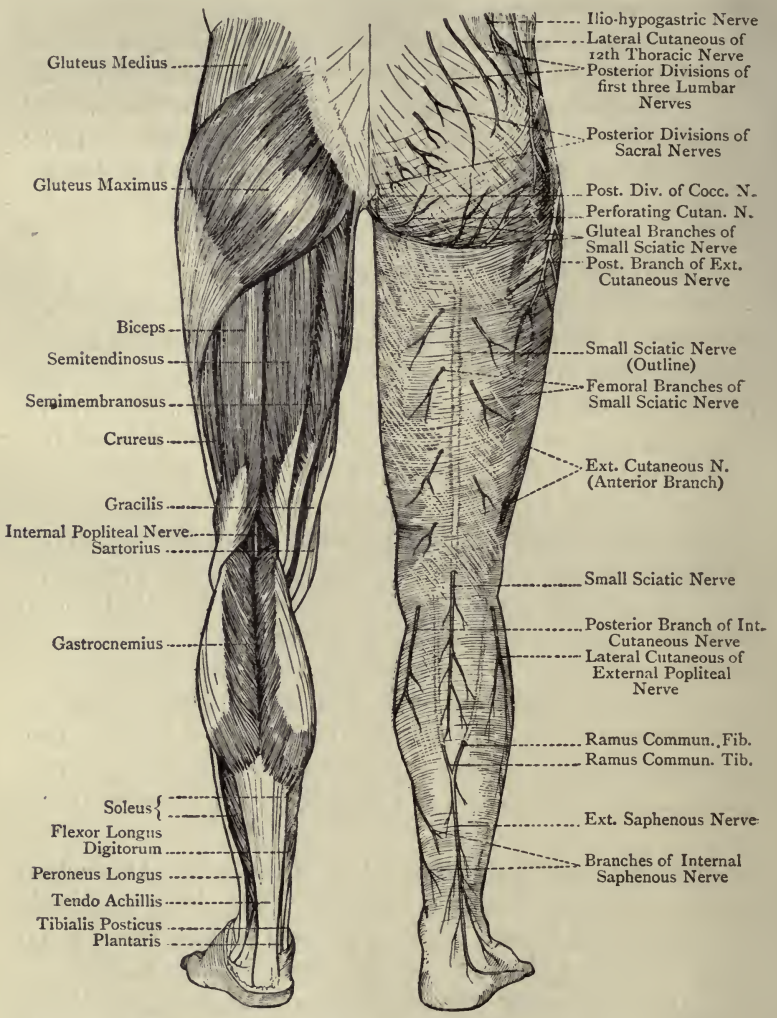


FIG. 70.—MUSCLES AND CUTANEOUS NERVES OF LEG (POSTERIOR VIEW).

external plantar nerves, beneath the internal annular ligament.

Branches.—In the popliteal space:

Muscular to gastrocnemius, plantaris, soleus, and popliteus.

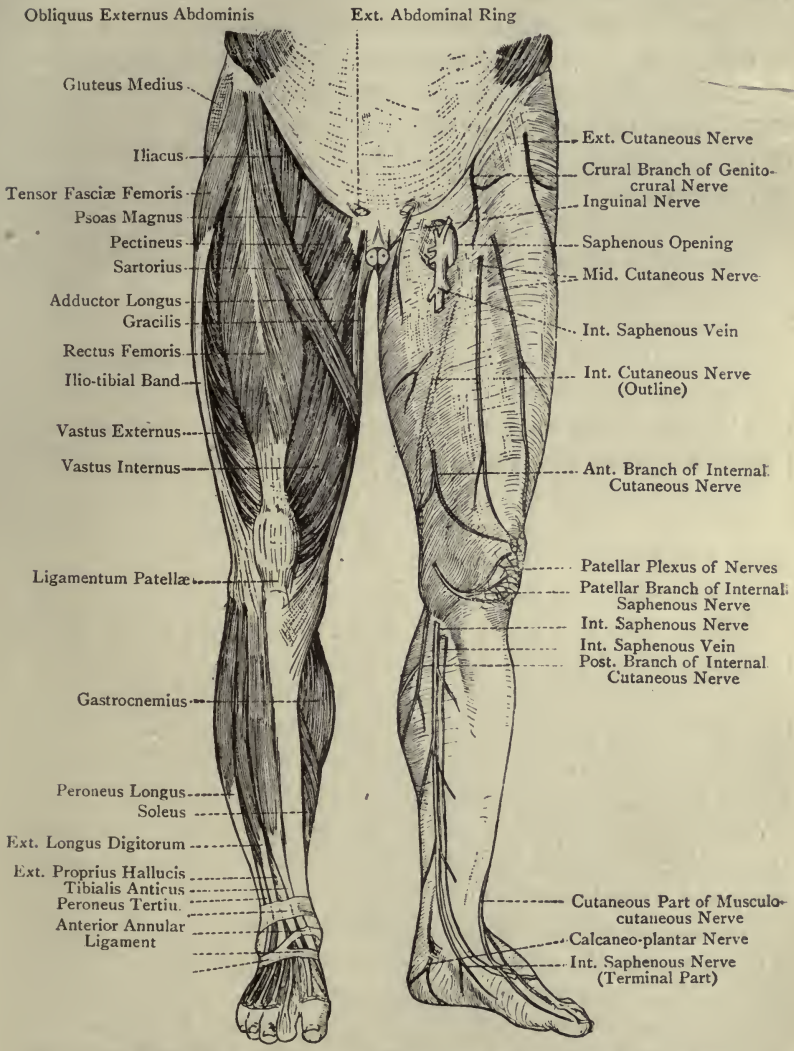


FIG. 71.—MUSCLES AND CUTANEOUS NERVES OF LEG (ANTERIOR VIEW).

The latter nerve winds round the lower border of the muscle and enters its deep surface, giving off a branch to tibialis posticus.

Articular.—Several to knee-joint, and one to the upper tibio-fibular joint, and to tarsal and metatarsal joints through the short saphenous nerve.

Cutaneous.—The tibial communicating, pierces the deep fascia in the middle third of the leg, where it is joined by the peroneal communicating, to form the short saphenous nerve which supplies the skin on the back of the leg, and, passing behind the external malleolus, supplies the ankle and heel and outer side of the foot and little toe.

In the back of the leg:

Muscular to soleus, tibialis posticus, flexor longus hallucis and flexor longus digitorum.

Cutaneous to the skin of the heel and the posterior part of the sole of the foot by a branch called the internal calcanean.

Internal Plantar Nerve.—A terminal branch of the posterior tibial nerve arises beneath the internal annular ligament, and passes forwards between abductor hallucis and flexor brevis digitorum with the internal plantar artery.

Branches.—*Muscular* to abductor hallucis, flexor brevis digitorum, flexor brevis hallucis, and first lumbrical.

Articular to inner tarsal and metatarsal joints.

Cutaneous to the inner half of the sole of the foot and the three and a half toes on the inner side.

The **External Plantar Nerve**, one of the two terminal branches of the posterior tibial nerve, arises beneath the internal annular ligament, and passes outwards with the external plantar artery between flexor brevis digitorum and accessorius.

Branches.—*Muscular* to all the muscles in the sole of the foot except those supplied by the internal plantar nerve; the interossei, and three lumbricals on the outer side.

Articular to the tarsal and metatarsal joints.

Cutaneous to the skin of the outer half of the sole of the foot and the one and a half toes on the lateral side.

The **Pudendal Plexus** is formed by branches from the anterior division of the first three sacral nerves, of the fourth and fifth sacral nerves, and the coccygeal nerves. It is formed on the back wall of the pelvis, and is distributed to the perineum (mainly by the pudic nerve) except for a few visceral branches.

Branches.—From the plexus :

Muscular to levator ani, coccygeus, and external sphincter.

Cutaneous to the lower part of the buttock by means of a branch called the perforating cutaneous nerve.

The **Pudic** nerve arises from the second, third, and fourth sacral nerves; it passes through the sacro-sciatic foramen, and lies on the spine of the ischium on the inner side of the internal pudic artery. It then enters the perineum with the artery through the small sacro-sciatic foramen. The nerve supplies all the muscles and skin of the perineum.

SECTION XVII

CRANIAL NERVES

THERE are twelve pairs of cranial nerves emerging on each side of the base of the brain, which supply the tissues of the head and neck (see Fig. 61).

Name of Nerve.	Function.	Exit from Brain.	Distribution.
1. Olfactory	Sensory	Olfactory bulb	To mucous membrane of nose
2. Optic	Sensory	Optic thalamus	To eyeball
3. Oculo-motor	Motor	Crus cerebri	To muscles of eyeball
4. Trochlear	Motor	Superior medullary velum	To muscle of eyeball
5. Trigeminal	Mixed	Pons varolii	Sensory to face, tongue, and teeth; motor to muscles of mastication
6. Abducent	Motor	Junction of pons and medulla	To muscle of eyeball
7. Facial	Mixed	Pons varolii	Motor to muscles of scalp and face; sensory to tongue
8. Auditory	Sensory	Pons varolii	To internal ear
9. Glosso-pharyngeal	Sensory	Medulla	To tongue and pharynx
10. Pneumogastric or vagus	Sensory	Medulla	To pharynx, œsophagus, stomach, and respiratory organs
11. Spinal accessory	Mixed	Medulla	Accessory to vagus; motor to trapezius and sterno-mastoid
12. Hypoglossal	Motor	Medulla	To muscles of tongue

The above table shows briefly the essential points as to the functions and distributions of the nerves, but some of them must be described in fuller detail.

5. The **Trigeminal** nerve arises from the outer surface of the pons varolii, and passes forward on the base of the skull to the apex of the petrous portion of the temporal bone. There it divides into three trunks :

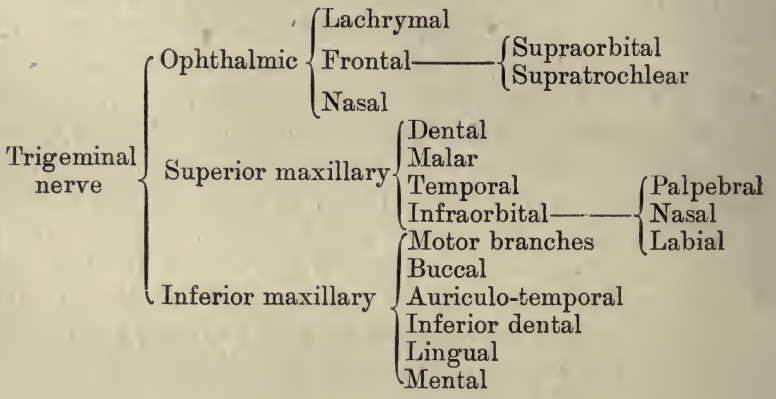
(1) Ophthalmic—entirely sensory.
(2) Superior maxillary—entirely sensory.
(3) Inferior maxillary—sensory and motor.

(1) The **Ophthalmic** division passes through the sphenoidal fissure and divides into three branches—(*a*) lachrymal, (*b*) frontal, and (*c*) nasal. The *lachrymal* nerve passes along the outer side of the orbit and supplies the lachrymal gland, the conjunctiva and skin of the outer corner of the eye. The *frontal* nerve passes forwards in the upper part of the orbit, and divides into the supraorbital and supratrochlear nerves, which pass through the supraorbital notch and inner corner of the eye respectively, and supply the skin of the forehead and scalp, the supraorbital nerve reaching as far back as the vertex. The *nasal* nerve enters the nose to supply the mucous membrane, and sends an external branch to supply the skin of the lower part of the nose.

(2) The **Superior Maxillary** division passes through the foramen rotundum in the root of the pterygoid process, passes through the orbit, and emerges on the face through the infra-orbital foramen. Before reaching the face the nerve gives off three *dental* branches for the supply of the upper teeth, and two branches, the *temporal* and *malar* respectively, which emerge from foramina in the malar bone, and supply the skin over that bone and the fore-part of the temple. The *infraorbital* nerve itself divides into numerous branches, which are arranged in three sets—palpebral for the skin of the lower eyelid, nasal for the skin on the side of the nose, and labial for the skin of the upper lip.

(3) The **Inferior Maxillary** nerve passes through the foramen ovale in the base of the skull and enters the pterygoid region ; it gives off branches to supply the muscles of mastication—viz., temporal, masseter, internal and external pterygoid, and buccinator. It then gives off five named branches—(*a*) the

buccal, which supplies the skin over the buccinator muscle and the mucous membrane inside the cheek; (*b*) the *auriculo-temporal,* which supplies the skin over the temple and the scalp just above; (*c*) the *inferior dental,* which supplies the lower teeth; (*d*) the *lingual,* which supplies the mucous membrane covering the anterior two-thirds of the tongue; (*e*) the *mental,* which supplies the skin over the chin.



7. The **Facial** nerve passes out from the border of the pons varolii and through a canal in the petrous portion of the temporal bone. It emerges from the skull through the stylo-mastoid foramen, and breaks up in the substance of the parotid gland to supply the muscles of the face. Directly after emerging from the stylo-mastoid foramen the nerve gives off three small branches, which supply respectively the stylo-hyoid, posterior belly of digastric, and the intrinsic muscles of the ear, and this latter also gives a branch to the posterior belly of occipito-frontalis.

In the parotid gland the nerve breaks up into two main divisions—the temporo- and cervico-facial—each of which divides into three sets of branches. This arrangement is called the pes anserinus.

The **Temporo-Facial** divides up into—(1) temporal, (2) malar, and (3) infraorbital branches, which supply the muscles of expression in their vicinity.

The **Cervico-Facial** divides up into—(1) buccal, (2) superior mandibular, and (3) inferior mandibular, all supplying muscles of expression; the latter branch supplies also the platysma muscle.

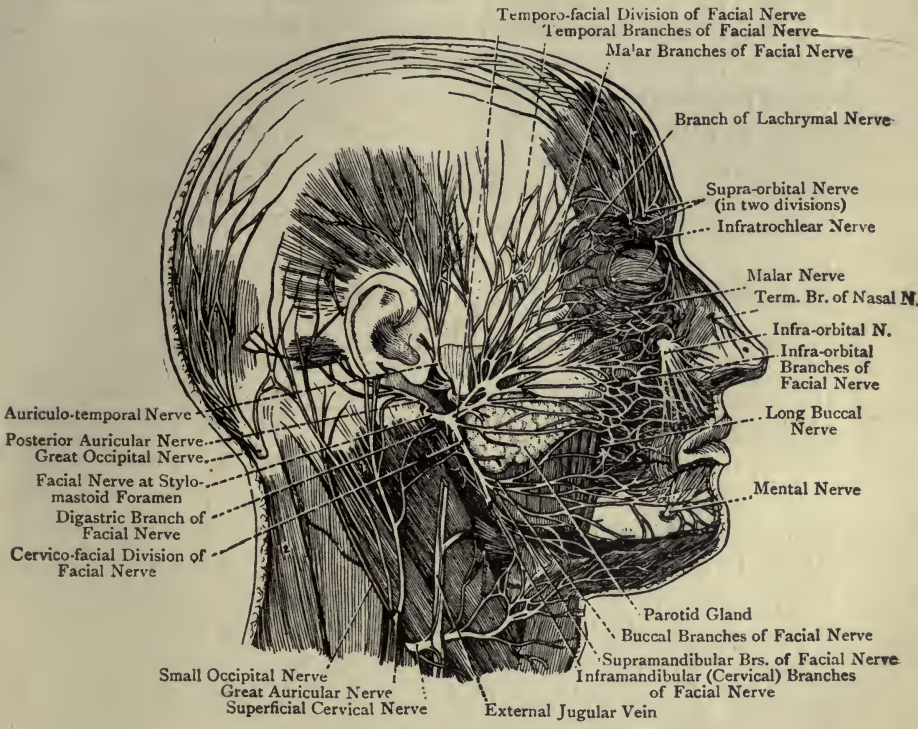
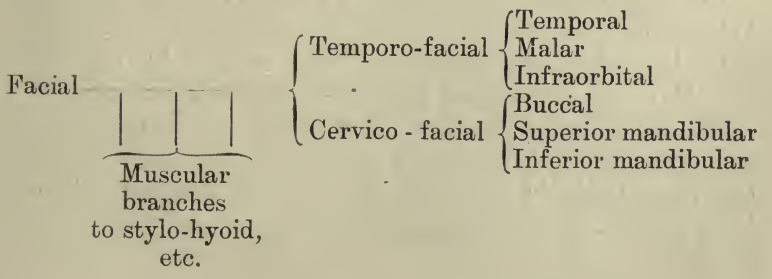


FIG. 72.—NERVES OF HEAD AND FACE.

1, Sterno-cleido-mastoid; 2, Trapezius.



9. The **Glosso-Pharyngeal** nerve emerges from the surface of the medulla oblongata, and passes through the jugular foramen with the pneumogastric and spinal accessory nerves. It passes down between the internal carotid artery and the jugular vein, then between the internal and external carotid arteries, and passes inwards to reach the tongue. The nerve supplies the stylo-pharyngeus muscle and the mucous membrane of the tongue and pharynx.

10. The **Pneumogastric** or **Vagus** nerve emerges from the surface of the medulla oblongata, and passes through the jugular foramen with the glosso-pharyngeal and spinal accessory nerves. The nerve lies in the carotid sheath lying between the artery and the jugular vein. It then enters the thorax behind the large veins (on the right side it crosses the subclavian artery, on the left it lies between the common carotid and subclavian arteries and crosses the arch of the aorta). As the nerves cross the arteries they each give off the recurrent laryngeal branches—the one hooking round the subclavian artery, and the other round the arch of the aorta. The nerve then passes behind the root of the lung, where it breaks up into branches to form the posterior pulmonary plexus, from which it sends two branches to join with similar ones from the other nerve to form a plexus in front of the œsophagus. A branch from the left nerve then passes down in front of the œsophagus, one from the right behind the œsophagus, and terminates by supplying the stomach and other abdominal organs.

The pneumogastric nerve supplies—

In the neck—laryngeal and cardiac branches.

In the thorax—laryngeal, pulmonary, and œsophageal branches.

In the abdomen—stomach and branches to the cœliac, splenic, renal, and hepatic plexuses.

11. The **Spinal Accessory** nerve is formed in two parts—one in the medulla oblongata, the other from the spinal cord—the two roots unite to form one trunk, which passes through the jugular foramen with the glosso-pharyngeal and pneumogastric

nerves. It passes down in the carotid sheath, and ends by supplying sterno-mastoid and trapezius.

12. The **Hypoglossal** nerve emerges from the surface of the medulla oblongata and passes through the anterior condyloid foramen. It then passes down the neck on the outer side of the internal carotid artery, and hooks round the occipital artery to reach the tongue, the intrinsic muscles of which it supplies.

SECTION XVIII

SURFACE MARKINGS

The Head.

About the head, the important structures whose positions are required are the nerves; these have already been indicated in their own section.

The Neck.

The neck is divided up into compartments by the fascial processes dipping in between the muscles. The most important one is the *central* or *visceral* compartment, bounded anteriorly by the pretracheal fascia, posteriorly by the prevertebral fascia, and laterally by the fascia enveloping the vascular compartment which contains the carotid artery, internal jugular vein, vagus nerve, and a chain of lymphatic glands; they all lie just underneath the sterno-mastoid.

The *central* or *visceral* compartment lies in the middle line of the neck, and extends from the base of the skull into the mediastinum; anteriorly it is divided by the hyoid bone into supra- and infrahyoid portions. Below the hyoid bone can be felt the cartilages of the larynx covered by a thin layer of muscles; and below them again the thyroid gland, whose middle portion lies over the second, third, and fourth rings of the trachea.

The *trachea* starts at the level of the sixth cervical vertebra, and divides at the level of the fourth dorsal vertebra; it gradually recedes as it passes down, and at the level of the upper border of the sternum is $1\frac{1}{2}$ inches from the surface.

The Thorax.

The thorax has been divided up into areas by the use of transverse and vertical lines:

Mid-sternal—indicated by a furrow between the origins of the pectoralis major muscles.

Mid-clavicular—a line dropped from the mid-point of the clavicle; should be continuous with the vertical Poupart line, and passing through the tip of the ninth costal cartilage.

Parasternal—a line drawn midway between the side of the sternum and the mid-clavicular line, and passes through the tip of the eighth costal cartilage.

Mammary region—between two transverse lines drawn at the levels of the third and sixth chondro-sternal articulations.

The *upper border* of the *sternum* is on a level with the lower border of the second dorsal vertebra, and about 2 inches distant from it. The junction of the manubrium with the body of the sternum forms a marked prominence—Ludwig's angle; at this point the second costal cartilage articulates.

The Lungs.—The *apex* of the lung extends upwards for one to two inches above the anterior extremity of the first rib, and is indicated by a curved line drawn from the upper border of the sterno-clavicular articulation to the junction of the inner and middle thirds of the clavicle, the highest part of the curve being from ½ inch to 1½ inches above the clavicle. The apex of the right lung is ½ inch higher than that of the left. The subclavian artery lies on the cervical pleura covering the apex of the lung.

The *anterior border* of the *right lung* is indicated by a line drawn from the upper border of the sterno-clavicular articulation to the centre of the manubrium, and thence vertically downwards, slightly to the left of the middle line, to the level of the sixth or seventh costal cartilage.

The *anterior border* of the *left lung* is indicated by a similar line as far as the fourth costal cartilage; thence along the lower border of the cartilage to the parasternal line, then downwards, to the upper border of the sixth costal cartilage in the parasternal line.

The *lower border* of the lung is the same on both sides, and is indicated by a line drawn from the lowest point of the anterior border along the sixth costal cartilage to the mid-clavicular line, and then curving slightly downwards across the chest to the

spine of the tenth dorsal vertebra; this line crosses the eighth rib at the side and the tenth rib at the back.

The *pleura* is a little larger than the lungs, especially inferiorly.

The Heart.

The surface markings of the heart are already given on p. 137.

The Abdomen.

The abdomen is most prominent in the region of the *umbilicus*, which is situated normally below the mid-point between the infrasternal notch (formed by the seventh costal cartilage and lower border of sternum) and the symphysis pubis, a little below the level of the highest part of the iliac crest and opposite the fourth lumbar vertebra; in obese or pendulous abdomens it may be considerably below this level.

The anterior abdominal wall is limited above by the infrasternal notch and costal margin, and below by the fold of the groin and crest of the pubes.

In a spare subject the recti and supra-umbilical portion of the linea alba are easily seen; if the outline of the rectus is obscured by fat, the outer border is indicated by a line drawn from the tip of the ninth costal cartilage down as far as the umbilicus, then curving forward to the pubic spine. In the angle between the outer border of the rectus and the ninth costal cartilage on the right side lies the *gall-bladder*.

The abdomen is arbitrarily divided into nine regions, by two vertical and two horizontal planes.

The *mid-clavicular* lines, continued downwards, cut Poupart's ligament in the mid-point between the anterior superior iliac spine and the pubic symphysis. (Note that this point is not the mid-point of Poupart's ligament.) In the abdomen these are called the Poupart planes.

The *upper* (*infracostal*) *plane* is at the level of the lowest part of the tenth costal cartilage, and passes through the third lumbar vertebra.

The lower (*intertubercular*) *plane* is at the level of the tubercles of the iliac crests, and passes through the fifth lumbar vertebra.

The subdivisions of the *upper zone* are called the epigastric

and right and left hypochondriac regions; of the *middle zone*, the umbilical and right and left lumbar regions; of the *lower zone*, the hypogastric and right and left iliac regions.

The *transpyloric plane* is midway between the suprasternal notch and the symphysis pubis; it passes through the first lumbar vertebra and almost always through the pylorus; hence its name.

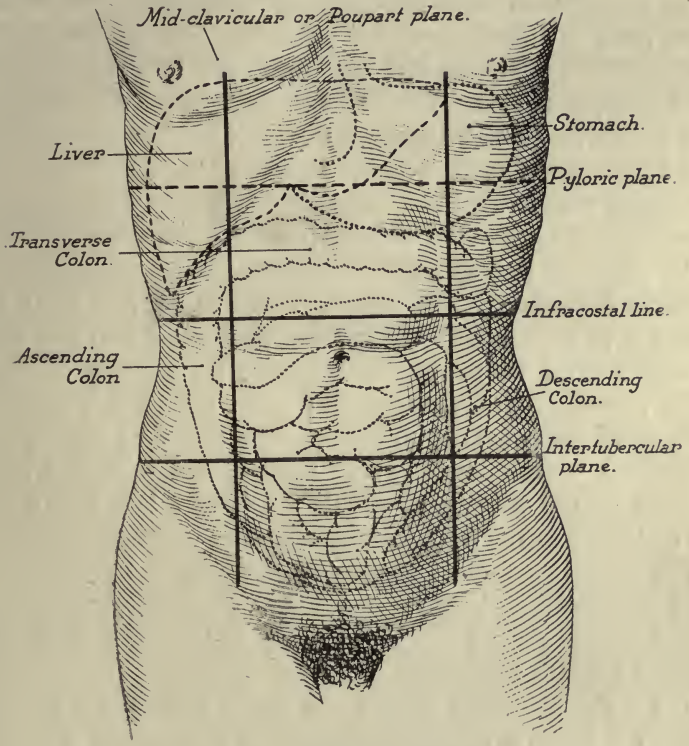


FIG. 73.—PLANE OF ABDOMEN.

The Liver.—In front the *lower border* of the liver can readily be felt as it crosses the costal angle; it passes from the eighth costal cartilage on the left side to the tip of the tenth on the right, and in the mid-line crosses the transpyloric plane. In the *mid-axillary* line it is a little below the level of the lowest part of the tenth right costal cartilage. The *upper border* reaches

from the fifth interspace on the left side to the fourth interspace on the right (both points in the mid-clavicular line).

The Stomach.—The stomach lies almost entirely in the left half of the epigastric and the left hypochondriac regions. The *cardiac orifice* lies 4 inches from the surface at a point over the seventh left costal cartilage, 1 inch from the sternum; the *pylorus* is generally about 1 inch to the right of the mid-line in the transpyloric plane; its position varies slightly according to the state of distension of the stomach. The highest part of the *fundus* of the stomach lies under the left cupola of the diaphragm, and reaches the fifth interspace in the mid-clavicular line, a little above and behind the apex of the heart; the lowest part of the great curvature lies between the transpyloric and infracostal planes.

Small Intestine.—The coils of the small intestine lie mainly in the umbilical and hypogastric regions.

Large Intestine.—The *cæcum,* which is in the right iliac region, is in contact with the anterior abdominal wall just above the outer third of Poupart's ligament; its position otherwise varies according to its dilatation; when empty, it is generally covered by coils of small intestine. The orifice of the *appendix* is opposite "McBurney's point," located on the surface at the junction of the upper and middle thirds of a line drawn from the umbilicus to the right anterior superior iliac spine.

The *ascending colon* lies deeply in the right lumbar region upon the quadratus lumborum and the right kidney.

The *hepatic flexure* lies immediately to the right of the gall-bladder beneath the tenth costal cartilage.

The *transverse colon* crosses the upper part of the umbilical region; it forms a **U**-shaped loop which reaches for a variable distance below the umbilicus; when the intestines are distended it may ascend in front of the stomach.

The *splenic flexure* reaches upwards behind the stomach, and touches the lower extremity of the spleen.

The *descending colon* lies deeply in the left lumbar region.

The *iliac* and *pelvic portions* of the *colon* lie in the left iliac fossa and true pelvis respectively.

The Kidneys.—Unless enlarged or displaced, the kidneys can

seldom be felt through the abdominal wall. The right kidney as a rule lies a little lower than the left, and a little further from the mid-line. For practical purposes the *hilum* of the kidney may be regarded as opposite a point ½ inch internal to the tip of the ninth costal cartilage; and a line joining the two hili is in the transpyloric plane.

The Abdominal Aorta.—The abdominal aorta commences about 1 inch above the transpyloric plane, and bifurcates a little to the left of the mid-line on a level with the highest part of the iliac crest, generally about ¾ inch below the umbilicus, opposite the fourth lumbar vertebra.

The Back.

In the middle line of the back is the *spinal furrow*, along which the spines of the vertebræ can be easily palpated, becoming more distinct when the spine is flexed.

The spine of the *first dorsal* vertebra is more prominent than that of the vertebra prominens (seventh cervical), the *third dorsal* is on a level with the root of the spine of the scapula, the *seventh dorsal* with its inferior angle, the *fourth lumbar* with the highest part of the iliac crest, and the *second sacral* with the posterior superior iliac spine.

Over the upper sacral region is a flattened triangular area, the angles of which correspond with the posterior superior iliac spines and the third sacral vertebra.

Above the spine of the scapula is the *suprascapular region*; the levator anguli scapulæ and trapezius muscles can easily be seen by shrugging the shoulders. The lower border of the *trapezius* is indicated by a line from the twelfth dorsal spine to the root of the spine of the scapula.

The *upper border* of the *latissimus dorsi* is indicated by a line extending outwards from the sixth dorsal spine across the angle of the scapula.

The outer border of the *erector spinæ* is indicated by drawing a line from a point on the iliac crest 3½ inches from the mid-line upwards and outwards to the angles of the ribs. The *outer border* of *quadratus lumborum* lies external to that of the erector spinæ at the iliac crest and internal to it at the twelfth rib.

As a rule the *tip* of the *twelfth rib* lies 2 inches vertically above the centre of the iliac crest.

The "*triangle of Petit*" is a narrow triangular space formed by the outer border of latissimus dorsi, the posterior border of obliquus externus, and the iliac crest.

The Kidneys.—The *upper limit* of the kidney is indicated by a line drawn transversely at the level of the eleventh dorsal spine, the *lower limit* by one at the level of the third lumbar spine. About a third of the kidney lies above the lower margin of the twelfth rib, the left kidney about ½ inch higher than the right. The *most external* point of the *outer border* lies 4 inches from the mid-line and the *hilum* lies 1½ inches from the mid-line between the tips of the transverse processes of the first and second lumbar vertebræ.

The Diaphragm and Liver.—Posteriorly the *right arch* of the *diaphragm* and the *right lobe* of the *liver* extend upwards to the level of the angle of the scapula (eighth rib), while the *left arch* lies 1 inch lower; the *central tendon* is on a level with the eighth dorsal spine. The *right lobe* of the *liver* is covered posteriorly by the eighth to the twelfth ribs.

The Spleen is situated in the left hypochondrium behind the cardiac end of the stomach, and is overlapped by the ninth, tenth, and eleventh ribs, the long axis corresponding to that of the tenth rib.

The *anterior angle* is at the level of the ninth interspace in the mid-axillary line. The *vertebral angle* lies 1½ inches external to the tenth dorsal spine. The *inferior angle* lies opposite the eleventh interspace on a level with the first lumbar spine: with these points the whole organ can be mapped out.

The Upper Extremity.

The Shoulder.—The shaft of the *clavicle* is subcutaneous throughout. The tip of the *acromion* lies a little external to and in front of the outer end of the clavicle; and its outer border can be followed round along the spine of the scapula, the root of which is on a level with the third dorsal vertebra. The inferior angle and internal border of the *scapula* are easily felt. The tip of the *coracoid* process can be felt at the anterior border

of the deltoid 1 inch below the point joining the middle and outer thirds of the clavicle. Internal to the coracoid process is a triangular depression between pectoralis major and deltoid; in this depression can be felt the axillary artery.

The rounded contour of the shoulder is formed by the upper end of the *humerus* covered by the deltoid; both tuberosities can be felt; the head of the humerus can be felt through the axilla.

The Axilla.—The anterior fold of the axilla is formed by the lower border of pectoralis major and the posterior fold by latissimus dorsi and teres major; between the two folds is the prominence of coraco-brachialis, behind which can be felt the third part of the axillary artery. High up in the axilla a few lymphatic glands can be felt.

The Upper Arm.—The anterior and posterior borders of the *deltoid* can be traced in their whole extent; just under the posterior border, about half-way down, the *circumflex artery* and *nerve* and the *musculo-spiral nerve* enter the arm. The *internal supracondyloid triangle*, limited by the internal intermuscular septum posteriorly, and whose floor is formed by the inner part of brachialis anticus, contains many important structures; from without inwards, the *brachial artery*, the *median nerve*, the *lower part of the basilic vein*, the *internal cutaneous nerve*, and two or three lymphatic glands.

The *external intermuscular septum* extends upwards from the external condyle to the insertion of the deltoid, and is pierced a third of the way down by the *musculo-spiral nerve*.

The posterior compartment of the upper arm is occupied by the *triceps*, the tendon of which can be felt at its insertion into the olecranon.

The *brachial artery*, overlapped above by coraco-brachialis and below by biceps, can be felt throughout the whole length of the internal bicipital furrow. The course of the vessel is mapped out by a line drawn from the inner border of the coraco-brachialis, at the level of the posterior fold of the axilla, to a point (opposite the neck of the radius) $\frac{1}{2}$ inch below the middle of the bend of the elbow.

The *cephalic vein* ascends internal to the outer edge of triceps to the interval between the deltoid and pectoralis major.

The line of the *median nerve* is the same as that of the brachial artery. The course of the *ulnar nerve* is mapped out by a line extending from the posterior fold of the axilla behind coraco-brachialis to the back of the internal condyle of the humerus.

The course of the *musculo-spiral* nerve is mapped out by a line drawn from the point where it pierces the intermuscular septum (the junction of the upper and middle thirds of a line extending from the insertion of the deltoid to the external condyle) to the front of the external condyle; and obliquely upwards to the point where the posterior fold of the axilla joins the upper arm.

The Elbow.

The *head of the radius* can be felt 1 inch below the external condyle of the humerus when alternately pronating and supinating the flexed forearm.

The *median vein* is seen to bifurcate ½ inch below the middle of the bend of the elbow; deep to this, beneath the fascia, is the *bifurcation* of the *brachial artery*.

The *biceps tendon* can be traced vertically through the centre of the bend of the elbow with the forearm flexed.

The Forearm and Hand.

The lower half of the *radius* is easily felt, and the anterior border of the lower extremity forms a ridge 1 inch above the ball of the thumb, and just below is the *radio-carpal articulation*. Upon the middle of the posterior border of the lower extremity is the *radial tubercle* between the tendons of extensor longus pollicis and extensor carpi radialis brevior.

The posterior border of the *ulna* is subcutaneous throughout, and its lower extremity forms a rounded prominence anterior to which is the *styloid process*. Between the two lies the tendon of extensor carpi ulnaris.

The *carpal bones* form an arch bridged by the *anterior annular ligament*; the bony attachments of the latter form important landmarks.

The *tubercle* at the base of the *third metacarpal* can be felt 1¾ inches below the tubercle on the back of the lower end of the radius.

The *prominences* of the *knuckles* are formed by the heads of the metacarpal bones.

Anteriorly, the *metacarpo-phalangeal articulations* are situated ¾ inch above the level of the web of the fingers.

The course of the *radial artery* is indicated by a line drawn from the bifurcation of the brachial artery to the tubercle of the scaphoid.

The upper third of the *ulnar artery* follows a curved line from the bifurcation of the brachial artery to the inner side of the anterior surface of the forearm; the lower two-thirds are on a line drawn from the front of the internal condyle to the pisiform bone. The course of the *ulnar nerve* corresponds to the whole of that line.

The *median nerve* may be mapped out by a line drawn from a point midway between the mid-point of the bend of the elbow and the internal condyle to a point midway between the two styloid processes.

The *radial nerve* follows the radial artery in the upper part of its course; at the junction of the middle and lower thirds of the forearm it winds round beneath supinator longus to the back of the forearm.

The summit of the *superficial palmar arch* is on the mid-point of a line drawn from the lowest transverse crease on the wrist to the root of the middle finger. The *deep arch* lies transversely midway between the lower border of the anterior annular ligament and the superficial arch.

The Lower Extremity.

The *buttock* extends from the crest of the ilium above to the gluteal fold below. The highest point of the *iliac crest* is on a level with the fourth lumbar spine; the *anterior superior spine* of the ilium limits the groin externally; the *posterior superior spine*, indicated on the surface by a dimple, is on a level with the second sacral spine, and corresponds to the middle of the *sacro-iliac joint*. A hand's breadth below the *tubercle* of the crest is the *great trochanter* of the femur, which is best felt if the limb is slightly abducted and rotated.

Nélaton's line, drawn from the anterior superior spine of the

ilium to the ischial tuberosity, crosses the hip at the level of the upper border of the great trochanter.

The *ischial tuberosity*, in the erect posture, is overlapped by the lower border of gluteus maximus; it can be felt a little above the inner part of the gluteal fold. If the hip be rotated inwards, the *lesser trochanter* can be felt above the outer end of the gluteal fold.

Anteriorly the buttock is limited by the *tensor fasciæ femoris* muscle.

At a point corresponding to the junction of the upper and middle thirds of a line drawn from the posterior superior spine of the ilium to the ischial tuberosity, the *gluteal artery* and *great sciatic nerve* enter the buttock; from this point the nerve passes downwards and outwards upon the ischium to a point midway between the tuberosity and the great trochanter.

The Back of the Thigh.

The *hamstring muscles* are thrown into prominence by standing on tiptoes, or by flexing the leg against resistance; at the same time a well-marked furrow indicating the *external intermuscular septum* of the thigh is seen; behind this furrow is the biceps, and in front of it the vastus externus.

The course of the *great sciatic nerve* corresponds to the upper half of a line extending from a point midway between the ischial tuberosity and the great trochanter to the middle of the popliteal space; the *small sciatic nerve*, indicated by the same line, descends superficial to the biceps, while the *great sciatic nerve* lies under cover of it.

The *external popliteal nerve* can be felt as it descends immediately behind the tendon of biceps and the head of the fibula.

The *internal popliteal nerve* and *popliteal vessels* are indicated by a line drawn from a point a little internal to the upper angle of the popliteal space, to a point midway between the condyle of the femur, and thence down the middle of the space to the level of the lower part of the tubercle of the tibia.

The Front of the Thigh.

Poupart's ligament, in the fold of the groin, divides the front of the thigh from the abdomen. Comparative measurements of the length of the limbs are made from the anterior superior spine of the ilium to either of the malleoli with the pelvis horizontal.

The *long saphenous vein* is indicated by a line drawn from the adductor tubercle of the femur to the lower part of the saphenous opening (1½ inches below and external to the pubic spine).

The course of the *femoral artery* is mapped out, with the thigh slightly flexed and rotated outwards, by a line drawn from a point midway between the anterior superior spine and the symphysis pubis, to the adductor tubercle of the femur; the upper third of this line corresponds to the part of the artery in Scarpa's triangle, and the middle third to that in Hunter's canal.

The Knee.

The *patella* can be easily outlined and moved from side to side with the knee extended and the quadriceps relaxed; with the quadriceps contracted the patellar ligament can be traced to its insertion. In semiflexion, the inner margin of the internal condyle, the upper border of the inner tuberosity of the tibia, and the lower part of the patella, are distinctly visible, and together bound a triangular depression which overlies the line of the joint and the anterior part of the internal semilunar cartilage.

The Leg.

The inner surface of the *tibia* is subcutaneous throughout.

The shaft of the *fibula,* somewhat posterior to the tibia, is only subcutaneous just above the malleolus.

The *extensor* and *peroneal* muscles, when thrown into action, are mapped out on the surface by grooves corresponding to the intermuscular septa.

The cutaneous part of the *musculo-cutaneous* nerve corresponds to the lower half of a line drawn from the anterior border of the head of the fibula to the anterior border of the external malleolus.

The *anterior tibial artery* enters the leg two inches below the

tubercle of the tibia; in the upper two-thirds of its course it lies on the interosseous membrane; in its lower third it lies on the front of the tibia and terminates in front of the ankle-joint midway between the two malleoli.

The *short saphenous vein*, which lies a little to the outer side of the tendo Achillis, gradually reaches the middle of the calf and ascends to the popliteal space. The *internal saphenous vein* and *nerve* lie along the inner border of the tibia.

The course of the *posterior tibial artery* is indicated by a line drawn from the lower angle of the popliteal space to a point midway between the internal malleolus and the tendo Achillis. The *peroneal artery*, beginning three inches below the head of the fibula, is indicated by a line from that point to one midway between the external malleolus and the tendo Achillis.

The Foot.

The tip of the *external malleolus* is $\frac{1}{4}$ inch lower and $\frac{3}{4}$ inch posterior to that of the *internal malleolus*. The *line of the ankle-joint* can be felt on either side of the extensor tendons, and when the foot is extended a prominence is formed by the anterior part of the superior articular surface of the astragalus below the anterior border of the lower end of the tibia.

A finger's breadth below the tip of the internal malleolus is the *sustentaculum tali*; $1\frac{1}{4}$ inches in front of the latter is the *tubercle of the scaphoid*; close above it is the *tendon of tibialis posticus*.

A finger's breadth below the tip of the external malleolus is the *peroneal tubercle* of the os calcis, a guide to the two *peronei tendons*.

The line of the *tarso-metatarsal joints* extends nearly 1 inch further forwards on the inner than on the outer surface of the foot.

The *metatarso-phalangeal joints* are situated one inch behind the web of the toes.

Crossing the front of the ankle-joint, from within outwards, are the *tendons* of *tibialis anticus, extensor longus hallucis, extensor longus digitorum*, and *peroneus tertius*. The *extensor brevis digitorum* forms a fleshy pad over the calcaneo-cuboid joint. The

abductor hallucis forms a fleshy pad along the inner border of the foot.

The *dorsalis pedis artery* is mapped out by a line drawn from a point midway between the two malleoli (the termination of the anterior tibial artery) to the hinder end of the first interosseous space. The *internal saphenous vein* and *nerve* lie between the internal malleolus and the tendon of tibialis anticus; the *external saphenous vein* and *nerve* follow the tendon of peroneus brevis.

The *internal plantar vessels* and *nerves* lie along a line drawn from the under surface of the inner tuberosity of the os calcis to the interval between the first and second toes. The *external plantar vessels* and *nerves* are on a line drawn from the middle of the under surface of the heel to the fourth toe; the course of the *plantar arch* is mapped out by a line drawn across the sole from the inner side of the base of the fifth metatarsal to the hinder end of the first interosseous space.

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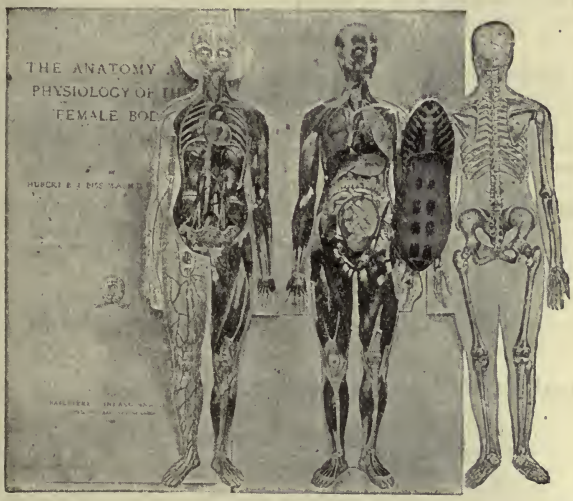

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